SCIENTIFIC AMERICAN SUPPLEMENT

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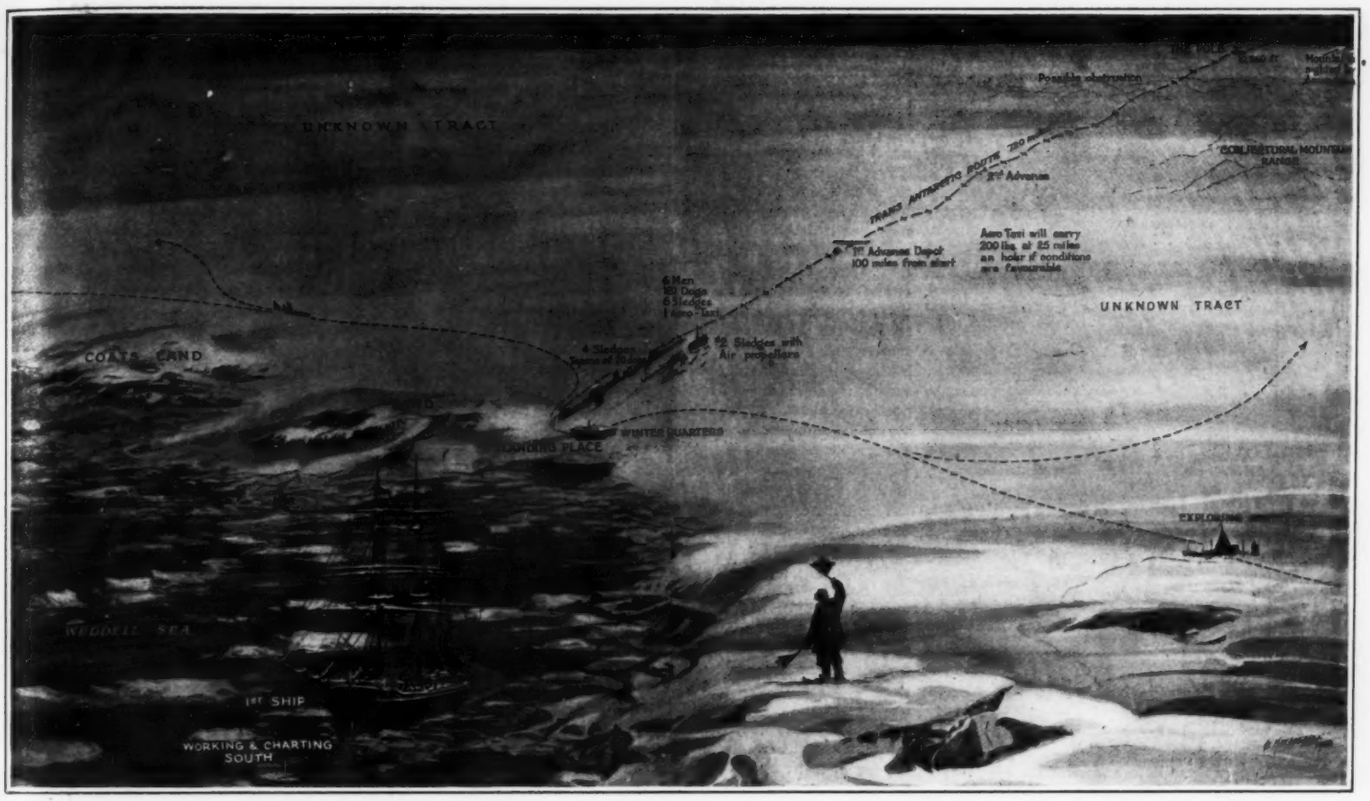

UNKNOWN TRACT
Possible observation
TRANS ANTARCTIC SOUTH 730 miles
2nd Advance
1st Advance Depot 100 miles from start
Aero Taxi will carry 200 lbs. at 25 miles an hour if conditions are favourable
6 Men 16 Dogs 6 Sledges 1 Aero-Taxi
2 Sledges with Air propellers
COATS LAND
WINTER QUARTERS
LANDING PLACE
UNKNOWN TRACT
WEDDELL SEA
1st SHIP
WORKING & CHARTING SOUTH

The proposed methods of transit from the Weddell Sea base to the pole. From a drawing made by D. Macpherson and here reproduced from the Sphere.

Diagrammatic view showing the second half of the transcontinental journey and the manner in which the second party will endeavor to help the first. Drawn by D. Macpherson, with the assistance of Sir Ernest Shackleton and here reproduced from the Sphere.

THE SHACKLETON ANTARCTIC EXPEDITION.—[See page 84.]

Illumination from Large Area Light Sources—II*

Some Experiments Carried Out With Actual Home Conditions

By Herbert E. Ives

Continued from SCIENTIFIC AMERICAN SUPPLEMENT No. 1987, Page 71, January 31, 1914

ATTEMPTS TO ARTIFICIALLY APPROXIMATE THE CHOSEN DAYLIGHT DISTRIBUTION.

The General Problem.—As an interesting exercise, attention was turned to ways and means for reproducing artificially the best daylight conditions in the room described in the first part of this paper. It soon became evident that the problem was not a simple one. It appears, in fact, that there is just one solution, and

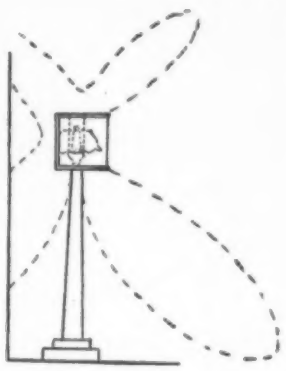


Fig. 5.—A side wall unit to approximate window conditions.

that is to reproduce entire the broad expanse of sky, houses and street. No small light source will copy all the qualities desired. For instance, while it is possible to produce at a given point in the room the general distribution of illumination and brightness given by daylight, the same lighting scheme will not produce the desired effect at another point. The problem is closely akin to that of producing a perspective drawing which would automatically change its perspective as the observer moved, or a photograph in which one could look around the corners by moving one's head from side to side. For instance, a horizontal plate placed above and outside the window would produce the desired sky effect near the window, but would fail farther back in the room. A vertical plate of low intrinsic brilliancy would take the place of the opposite houses as far as the eye of an observer within the room, but the sweep of tenfold brighter light across the floor and the brighter light on the ceiling would be missing. As it was not possible

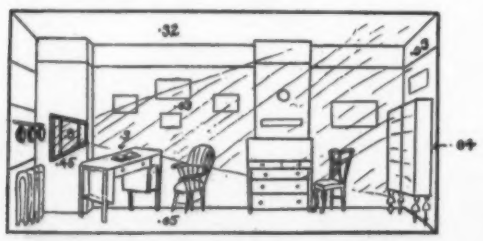


Fig. 6.—A point source copy of daylighting. (Brightness values are multipled by a factor 10.)

to light up "all out of doors," several approximations to the conditions given in Fig. 3 were attempted, which are described below. The first of these may be called a lighting fixture, the others lighting schemes, or, as a non-technical visitor described one of them: "Not lights, but light."

(1) *A Side Wall Fixture to Approximate a Window Effect.*—This fixture might be popularly described as "semi-indirect from the side" although it presents a number of deviations from what would be obtained by merely supporting a semi-indirect bowl out from the wall. In construction it might be most nearly described by saying it is a table lamp with the back half and top of the shade removed. In detail it consists of the light source, which should be of such form or provided with such a reflector as to throw its light chiefly below and above the horizontal about as does the prototype window curve, added to which is a large area translucent screen so calculated as to let the direct light fall upon the wall behind, the ceiling above and the whole floor of the room, and of such degree of translucency as to closely approximate the brightness of the illuminated wall behind. The device is shown in Fig. 5, where it is represented as a floor standard. From the plan and elevation it will be seen that for no normal position in the room is the bright part of the light source visible, but screen and wall form a large source of low intrinsic brilliancy. This is secured by the peculiar shape of the screen, which is concave to the light with respect to the horizontal plane half inclosing it, but only large enough vertically to conceal the light from the occupants of the room. The screens so far made up have been covered with flowered silk, or cretonne, and lend themselves admirably to the general decorative scheme.

This fixture when used in a room having light walls (a necessary condition gives to a large degree the desired window effect. The light s directed from the side giving the long pleasing shadows; there is a large measure of diffusion, due to the large area of the effective source; the floor and furniture have a pleasant "sun-lit" appearance. The thing of beauty is the light itself and not, as in many cases, a piece o' decorative metal work, designed to be viewed by daylight. The limitations to this device are the necessity for bright walls, which is not serious, and the fact that the direct light in the lower hemisphere cannot be made to fall as far out on the floor as with windows without carrying the shade too far in front of the light for convenience. It does, however, make an extremely pleasing light source and has, in several months of use, worn well. It is especially good if two or more are grouped at the window end of the room. It appears that the best height for these shades, if they are to be in the field of vision, is about on the level of the eyes. If a light source must be visible it seems to be less irritating at this line than at some degrees above. It is perfectly possible to make the shades and wall behind of such brightness that a person's face may be viewed against them as a background without undue contrast.

Side wall brackets have always been popular with those who wish their faces to appear at their best. The defect of most bracket fixtures has been that the light sources have an altogether too great intrinsic bri liancy and make excessive contrast with the wall behind, especially if the latter is dark wood, as it too often is. This defect is overcome in the arrangement here described. There has thus far been no dissenting opinion as to the excellent performance of these side wall 'windows."

(2) *An Alcove Light with Semi-window Characteristics.*—This scheme was tried out after a study of the window considered as a point source as shown in Fig. 4, and was carried through in full knowledge of the fact that the characteristics of a large window could not be completely copied without a comparatively large source. The plan is shown in Fig. 6, where *A* represents a line of light sources with aluminized scoop reflectors sending a large part of their light in the lower hemisphere and approximating the lower portion of the large circle of Fig. 4. At *B* is placed a frame 15 inches by 6½ feet covered with cretonne and muslin sheeting. This to an observer back in the room takes the place of the houses opposite, as a large area low brightness source. By trial such a thickness of fabric was found that the illumination back in the room due to it was one tenth that from the row of lights as seen below it from the floor, that is, the condition found best by daylight.

This installation is exceedingly interesting. With 7,200 lumens the surface brightnesses through the room measure up on an average one twelfth that found as the average of the two daylight distributions given in Fig. 3. It was found most desirable, however, to let considerable light go to the ceiling, which gives more light in the room and approximates more to the "sunlight" case of daylight distribution in Fig. 3. This, when the eye is adapted to night conditions, is very nearly ample at every point of the room. Probably twice as much would be more than enough. The room presents a strikingly daylight appearance, except for three things, all due to the same cause. First, the line of demarkation between the light from the "houses opposite" and the "sky" is too sharply marked on the walls; second, the specular reflections on the furniture, books, etc., near the windows, visible on entering the room, are relatively far brighter than they would be by day, as is to be expected; third, the shadows of the furniture are too sharp. These are all due to the point source character of the light, and are only to be seen above and below the parts illuminated by the cloth covered screen. The appearance is practically the same as can be obtained by covering all the windows except a narrow horizontal slit. Within the angle which receives light only from the screen and

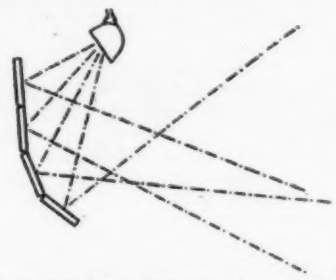


Fig. 7.—Section of special reflectors used for artificial window.

from walls and ceilings, the daylight character is almost startling.[1]

(3) *A Window Reflector.*—The requirement of a large-area concealed light source at the side, having the distribution curve of the window as a light source, may be approximated to by combinations of optical devices, such as prisms and reflecting surfaces. One of these devices forms the last experiment to be described.

In accordance with the subject matter of this paper it is clear that an "indirect" fixture, if directed toward the wall, would not give the desired window effect because, while the light source would be large, it would be of uniform brightness as viewed from all directions. In order to secure for this experiment the proper unsymmetrical distribution of brightness, recourse was had to reflecting surfaces intermediate between specular and matt. Measurement of a number of surfaces, such as scratch-brushed aluminum, aluminum paint, mirror glass covered with transparent curtain material, etc., led to the choice of ribbed mirror glass, sand-blasted on the front. Later it was found better to decrease the brightness of the diffuse component, and this was done by rubbing the sandblasted surface slightly with oil. Probably a lighter sandblasting would have given the desired quality. Such mirrors placed with the ribs vertical and illuminated by a light in front and above give a large semi-specularly reflected component, which is nevertheless so much diffused as to appear to come from a large area of mirror; and a small diffuse component, the ratio between the normal and reflected brightness being easily made one tenth by tilting the mirror.

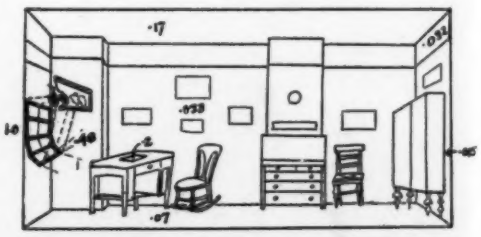


Fig. 8.—Artificial window lighting. (Brightness values multiplied by factor 10.)

* A paper presented at a meeting of the Philadelphia section of the Illuminating Engineering Society and published in the *Transactions of the Society.*

[1] If the windows be made horizontal slits of about 10 inches width and if the time of day is taken when the sun falls on the houses opposite, an extreme case of bad lighting is obtained. The illumination of the room is quite insufficient; there is a high ratio of brightness between the light source and its surrounding in the field of view; shadows are sharp and specular reflections are too bright. This illustrates clearly the importance of the light source being large and of having its brightest part concealed.

A pair of frames of these was made, as shown in Fig. 7, each frame consisting of four 7-inch by 30-inch elements. These frames were hung in the window, as shown in Fig. 8, and were illuminated by a row of small units in the aluminized concentrating reflectors used before. As shown in Fig. 7, the specular reflection from the three upper elements illuminates the floors and lower parts of the walls of the room. The bottom elements illuminate the ceiling, taking the place of the brightly lit street pavement before.

An observer sitting in the room sees these surfaces as of a uniform low brightness. On dropping his head he begins to see the top elements brighten, corresponding to the sky appearing over the house tops. On dropping still lower, the other elements brighten until at the floor the whole "window" appears a uniform sheet of light. On standing up and approaching the window the lowest elements become bright in the same manner. This copy of window conditions is in fact very close. The reflected light is, because of the ribs and the sandblasting excellently diffused. Shadows in the room are long and oft.

The excellence of the copy is shown by the relative brightness measurements. These indicate that the relative brightness of all visible objects is nearly the same as by daylight without the sun on the floor, as shown in Fig. 3, the actual brightness being close to one tenth of that of daylight. In fact, this imitation of daylight distribution in the room is, from the standpoint of relative brightness, direction of light and diffusion, so perfect as to leave outstanding only the factors of actual intensity of illumination and color of light.

Goo and Bad Features.—This reflector scheme has many elements of merit. It is in some respects almost uncanny, especially to one not looking toward the imitation windows. The sweep of light over the floor; the illumination of the low portion of the walls; the brightness ratio between ceiling and floor, are most striking and very different from the usual artificial light conditions. But the general effect is not pleasing. There is a harsh "contrasty" effect. The darker end of the room looks too dark; the windows too light; shadows are too inky black. The effect is very much like a foggy day, or as though the houses opposite were brilliantly sunlit. Why is this? In some part to mental bias, perhaps; the windows do not look just like real windows and one is strongly conscious of the fact. Also the fact that the light source is near, instead of distant, and that our ocular muscles of accommodation are quite conscious of the real state of affairs. The explanation of the greater part probably lies in two facts: first, the absolute intensity is too low, and, second, the color of the light is not white. The absolute intensity is about one tenth daylight intensity. My observation leads me to believe that a given physical ratio of brightness becomes subjectively greatly increased when the order of illumination is decreased as much as it is here. If a ratio of brightness of 10-1 for different points in the room is satisfactory by daylight then with 1-10 that illumination this ratio must be decreased to 5-1 or 3-1. With the low order of illumination the shadows, such as those on the room side of the face, are so dark as to appear nearly black; the high-light side alone is seen. By the greater light of day, although the relative brightness of the two sides of the face is the same, the dark side is bright enough to be easily seen; the bright side does not appear too bright. I can best describe the phenomenon by saying that the room under this 1-10 illumination looks like an underexposed photograph—the high lights alone come out. By exposing longer a good negative is obtained; by increasing the illumination tenfold I believe—unless the color difference has a great deal to say—that this copy of daylight would be "the real thing." Physically it measures up in the right proportion. Subjectively the proportion becomes distorted. I have found support for this idea by the experiment of wearing dark glasses of 1-10 transmission in this room when the daylight conditions are good. The conditions become trying at once. What is called for in the present case is an increase in total light, which cannot be made in the existing house installation without danger. Incidentally it may be remarked that this accentuation of contrasts merely means a larger value for the Fechner fraction at low illuminations, which is actually found by experiment.

The general effect in the room is enormously improved by adding the light from two side wall table lamps described above, placed in the corners next the alcove. These give somewhat more light, but more than that, they throw their added light upon the ceiling and side walls without increasing the brightness of the "windows." These latter cease to be too bright; the shaded side of the face becomes visible and a first rate effect is produced.

On turning off the window light alone the room seems to jump upward, showing very prettily the importance of the daylight effect of the sweep of light on the lower part of the room. I believe this window experiment would have been more successful had the room been provided with an artificial window at the side. A long dark room such as this is difficult to light by day; were it not on the south side of the house I believe it might be a failure. It certainly represents an extreme type. I am inclined to think another type of room, say a broad shallow one furnished with these artificial windows, might be quite successful, even without an increase in the amount of light.

The color of the light may have something to do with the harsh effect. As above noted blue light scatters much better than yellow. A photograph by ultra-violet light will show almost no shadows owing to scattered light from the dust particles in the air, while in infrared light shadows are black. Something of this sort may contribute to the inadequacy of this artificial window.

SUMMARY OF CONCLUSIONS AND SPECULATIONS ON ROOM LIGHTING BY LARGE AREA SOURCES.

Several conclusions which seem to be justified by these various experiments, are given as follows:

The desirable qualities sometimes found in window lighting by daylight are, (1) direction from the side; (2) soft shadows and low intensity of specular reflect on, due to the large size of the source; (3) the direction of a large part of the light on the lower, usually the darker, parts of the room, and (4) the concealment of the principal light source.

It appears possible to make a very close physical copy of the window as a light source whereby all the characteristics may be duplicated. An attempt to do this shows that to the above qualities must be added (5) large quantity of light as compared with what is usually available from artificial sources. It is suggested that this is less necessary if the artificial windows are placed so as to secure a more uniform distribution of illumination than is necessary by daylight.

These various qualities can be separated to some extent into necessities and luxuries; some are necessary for comfort, others appeal to the esthetic sense. I believe that in concealment of the light source, so that it is not the brightest object visible, in making it of large area and in introducing a certain amount of side light from large area, very low intrinsic brilliancy sources, most of the really necessary and many of the attractive characteristics of daylight may be obtained, with much lower intensity and, consequently, lower cost than a true copy of daylight would come to. I favor a combination of deck lighting for general floor and working plane illumination, with side wall lights of the type described above. I hope to report on an installation of this type at some future date. If the room is not too large nothing at present promises to excel the side wall window brackets of Fig. 5.

Fuel for Aircraft*

By Pegasus

In his presidential address to the Institution of Automobile Engineers, Mr. Critchley discussed the fuel question from the point of view of the motor-car, but the matter is one in which the aeroplane and the airship are also very deeply concerned. One of the great evils of the present high price of gasoline is the enormous cost of flying. It is estimated that the fuel and oil costs of an aeroplane of high power run into about $5 per hour of flight, and when it is realized that whereas two years ago Great Britain officially owned one aeroplane, it had 15 last year and now has from 120 to 150, and that with this increase have also come improvements which will give about 250 hours' flying for each machine annually the significance of high fuel costs will begin to be appreciated. It will be measured by a fuel and oil bill of about $150,000 a year at retail prices. Those who read the signs expect the rate of increase of aircraft to continue to 1,000 aeroplanes and many dozens of airships within the next two years, meaning probably a fuel and oil bill of quarter of a million sterling. The Army and Navy show a clear sign of having appreciated this situation in the published terms of the competition for engines which is to be held at the Royal Aircraft Factory next year. In this the weight limit is not placed on the engine itself at all, but on the weight of the engine with its fuel and oil for six hours' full-load run. In such a test fuel economy, whether due to high compression, which involves good cooling, or to fine carbureter design, will occupy a very prominent place. It would appear on the above supposition of development that aeronautics may be expected within two years to take one sixth part of the fuel consumption of all the motor-vehicles in Britain. O. the total consumption, estimated at about 100,000,000 gallons a year, it seems that 20,000,000 gallons are used by the omnibuses and taxicabs of London, while motorboats, motor-cycles, and sundry users take 10,000,000, so that on this basis the 100,000 vehicles in England take 70,000,000 gallons.

POSSIBILITIES OF BENZOL.

Well-washed and distilled benzol can be used as a substitute, without doubt. The amount of benzol produced in England is variously estimated at from 10 to 23 million gallons a year, most of it being derived from coke ovens. The reason why benzol is not much used depends partly on its price and partly on technical objection in the shape of smell, difficulty of starting the engine from cold, and slight increased sooting of the engine. To these may be added the fact that benzol freezes (unless it be mixed with toluol) at 42 deg. Fahr. The capital required to convert ordinary coke ovens into vertical retort ovens with by-product recovery is considerable. None the less it may, in a few years, be forthcoming, and then the British coke supply would correspond to a supply of some 30 million gallons of benzol.

The amount of energy in a pound of benzol is less than that in a pound of gasoline, but as it is much denser—say 0.880 instead of 0.73 for gasoline—the quantity of energy available from a gallon is greater. Where weight and space are as important as they are in aircraft the gain is chiefly by reason of the slightly smaller tank room and tank weight required for a flight of a given duration. Also, as aircraft engines are mostly used at constant speed and load, the carbureter question is much simpler than for the motor-car, with which load and speed vary so constantly. The suggestion is put forward that benzol will allow the use of higher compression pressures than are feasible with gasoline owing to pre-ignition. This is a matter which requires investigation with commercial benzol mixed with toluol, for it is noteworthy that pre-ignition may be determined by the presence of substances rich in hydrogen, even though the bulk of the fuel be benzol, which, as compared with the gasoline of commerce, is chiefly rich in carbon.

MIXED FUELS.

The suggestion of Dr. Buchner, quoted by Mr. Critchley, for a motor specially designed for working with benzol at 140 pounds per square inch compression is one which should most certainly be tried at an early date. More interesting still is the series of trials which resulted in showing that a mixture of equal parts of two fuels neither of which gave first-class results alone, the one from excess of cooling by evaporation of the fuel and the other from the heaviness which prevented the easy acceleration of the engine, gave better results in every way than were obtainable even with gasoline. The fuels were petrolem-ether, costing untaxed 7½c. per pound, and benzol costing 4 cents per lb. The tests were of the rough-and-ready type so convincing to the ordinary man; a car was run adjusted for gasoline, and better results in regard to speed and hill-climbing were obtained with the compound fuel. The subject will clearly repay study and will undoubtedly receive it. The real difficulty in England is that benzol is as dear as gasoline when the cost of distribution is added to it, as is done when taking the retail price of gasoline.

The quantities of naphthalene available at a very low price would make that substance an excellent fuel if truth attaches to the statement that a Belgian chemist has reduced it to a permanent liquid form by the addition of a harmless solvent. Naphthalene costs 75 cents a ton and has been used for car propulsion with success over some 60 miles in an official trial by the process of heating the carbureter which handles the molten fuel and using gasoline for the first quarter of an hour as a starter.

* From the *London Times Engineering Supplement*

The Source of Radium

Carnotite, the principal source of radio-active substances, is an ore of vanadium and uranium. Its principal occurrence in the United States is within the State of Colorado.

Carnotite is probably an alteration product of pitchblende, and is the mineral whence the major portion of our radium supply is derived, says a writer in the *Engineering and Mining Journal*. It was discovered by Charles Poulot late in 1887 or early in 1888 in the Roc Creek (or possibly La Sal Creek) district of Montrose County, Colorado. In the beginning small lots were shipped to a little wooden shed near the east end of Champa Street, Denver, where the ore was treated by Poulot and E. Cumenge, both chemists, who were associated with M. Voilleque in the rare metals business in Denver.

Poulot traveled extensively through Colorado and acquired a pitchblende deposit in Gilpin County, which he sold to the Roman Catholic Bishop Machboeuf of Denver. The latter died in 1890 and bequeathed it to his successor, Bishop Matz, who sold it in 1912 to Yale College for $10,000. Poulot was interested also in the tungsten deposits of Boulder County.

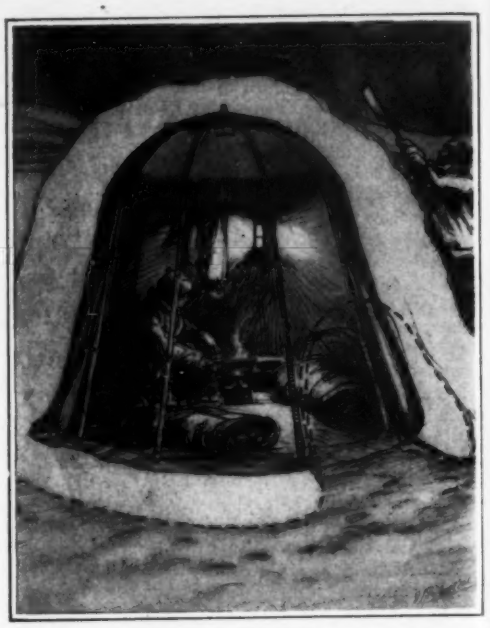
The uranium-vanadium mineral was named carnotite by Mr. Poulot in 1888 at the suggestion of Mr. Cumenge in honor of Marie Francois Sadi Carnot, President of France.

Sir Ernest Henry Shackleton.

Shackleton's Trans-antarctic Expedition of 1914*

The Study of Seas and Coastline of the Antarctic Continent Most Urgent

By William S Bruce



The dome-shaped tent convertible into an igloo.

THOUGH Sir Ernest Shackleton has adopted plans for an antarctic expedition that were formulated and published by me even before his return from his last expedition, and details of which have appeared since that time in various scientific journals, and in the public press,[1] my view has always been that one explorer should not stand in the way of another, but as soon as one has secured money—a task more arduous than carrying out any plan whatever in the field—he should carry out whatever plan he pleases, and should receive, if he desires, any assistance that the other may be able to give. Therefore I welcome Sir Ernest Shackleton entering what has for a century mainly been, so to speak, the Scottish sphere of influence in the antarctic regions.

It is a curious fact that those who have done the most strenuous work on antarctic land have been seamen, while landsmen have been left to carry out the most strenuous work in antarctic seas, and it is, perhaps, for this reason that Sir Ernest Shackleton concentrates his attention again mainly on the land, whereas, as I have already pointed out,[2] it is a study of "antarctic seas that is at present most urgent, including an exploration and definition of the southern borders of those seas," that is to say, the coastline of the antarctic continent. This part of the programme cannot be efficiently carried out in the time that Sir Ernest Shackleton proposes to allow himself, either for necessary preparation or for his expedition. Hurry is unfavorable to detailed scientific research.

But no one is better fitted than Shackleton to carry out to a successful issue the transcontinental journey, as is shown by the brilliant way in which he conducted his south polar expedition in 1907-1909. Shackleton is a trained seaman and a capable business man, appreciative of the work that scientific people carry out under his leadership. Abundant testimony to this fact has been given by his former colleagues, especially Dr. D. Mawson, Prof. Edgeworth David, and Mr. James Murray. It is certain, therefore, that he will give his scientific staff every opportunity of carrying out important scientific research.

Granted that his ship is able to reach Coats Land or Luitpold Land—and this is entirely dependent on whether it is a good or bad ice year in the Weddell Sea—the expedition should endeavor to unite and chart in more detail Coats Land and Luitpold Land. It should endeavor to map out the coast line between Coats Land and Enderby Land, between Coats Land and Luitpold Land, and between Luitpold Land and New South Greenland. The investigation of New South Greenland is in itself one of the most interesting and difficult problems of Weddell Sea. Detailed soundings should be taken, especially to the south and west of those of the "Scotia" and "Deutschland," so that, if new coastlines are not actually discovered, their presence and general outline may be indicated. This can be arrived at with a wonderful degree of accuracy. It is of great interest to obtain considerable quantities of bottom deposits, especially macroscopic specimens, along with indications of the distribution and drift of icebergs which have been the means of carrying them to the place

* Article reprinted from *Nature;* illustrations from the *Sphere.*

[1] *Scottish Geographical Magazine,* vol. xxiv., No. 4, April, 1908; vol. xxvi., No. 4, April, 1910. *Nature,* March 24th, 1910, p. 101; and October 27th, 1910, p. 551. "Polar Exploration," by W. S. Bruce, chap. x., pp. 252, 253. (Williams and Norgate, 1911.)

[2] "Polar Exploration," by W. S. Bruce, p. 247.

MR. FRANK WILD (Second in command) SIR ERNEST SHACKLETON DR. MARSHALL LIEUT. ADAMS

Sir Ernest Shackleton and the three members of the polar party that journeyed to within 111 miles of the pole in 1907-1909. Mr. Frank Wild, who will be second in command of the coming expedition, has been in no fewer than three south polar expeditions, namely, Scott's, 1901-1904; Shackleton's, 1907,-1909; and Mawson's, which started in 1911 and has not yet returned.

where they have been deposited. The important discovery of Archæocyathinæ at a depth of 1775 fathoms in latitude 62 degrees 10 minutes south, longitude 41 degrees 20 minutes west, is a lucid example of the value of this type of research, for it most certainly indicates that the Cambrian rocks found by Shackleton in the vicinity of the Beardmore Glacier stretch across Antarctica toward the shores of the Weddell Sea, and possibly form part of that mountain system seen by Morrell in about latitude 69 degrees south.[2]

But will Shackleton be able to spend time to carry on these researches when the main object is to cross the antarctic continent? On her outward voyage the ship will be full to the gunwale with stores and equipment, and every effort must be made to find a suitable landing place along a practically unknown coast, to build a house, and set up the base camp for the tremendous task of crossing Antarctica, and this along a coast that Ross failed to reach because of heavy ice in 1843, that the "Scotia" failed to reach in 1903, where the "Scotia," in 1904, was heaved right out of the water, and left stranded on the top of the ice, her keel being 4 feet above water level, and where the "Deutschland," in 1912, was beset and driven northward helplessly during the whole winter.

These are difficulties that may be met with again in the Weddell Sea, difficulties which have never been experienced by any ship in the Ross Sea, where no one has ever failed to reach the Ross Barrier. It is therefore to be hoped that Shackleton will not meet with such conditions, but will find a favorable season such as Weddell and Morrell found in 1823.

Once landed at or in the vicinity of Coats Land—more likely to the east than to the west—Shackleton starts his main objective. A meteorological station here will be of immense importance, and should be cooperative with those of the Argentine Republic in Scotia Bay and South Georgia. Detailed discussion of the meteorological programme with Mr. R. C. Mossman is strongly advised. Magnetic work of the usual kind at the base station and, so far as possible, on the cross journey will fall in with other work that has been done; in both these departments of science it would be specially profitable to have other expeditions in the field synchronously. Local zoological and botanical work will also be of great interest. But, undoubtedly, solving some of the many great topographical and geological problems is the leading work to be done both in the vicinity of the base station and in the interior.

According to evidence at present at our disposal, Shackleton, if he penetrates southward from Coats Land, will gradually rise without much interruption over completely and heavily ice-clad land—over inland ice, in fact—until he reaches the South Pole, an ice field that continues until it reaches the Beardmore Glacier and Axel Heiberg Glaciers. It would be a great triumph if, after Shackleton reached the South Pole, he could strike a new route, say, to the west of the mountains of South Victoria Land; but if this sacrifices the life or even limbs of the party, it is not worth attempting. Another expedition can carry out that work in time to come from the Pacific side. The intrinsic value of the expedition is to seek and find out what lies between Coats Land and the South Pole.

The route will probably be to the east of the antarctic continuation of the Andes, but possibly Shackleton may have to cross another range—the continuation of the South Victoria Land Mountains—but all is new, and all depends upon whether previous conceptions have been based on sufficient facts. It is expeditions such as Shackleton's that we require as the only way of obtaining data for the solution of many theories founded on too few facts. We therefore wish him all possible success, and trust that he will receive all the support he requires. The 50,000l. provided by a generous friend is an absolute minimum; 70,000l. is nearer the figure, and may we also trust that even another 10,000l. will be forthcoming to enable the gallant leader to have the scientific results of the expedition described in detail; for an expedition of this kind is not completely successful unless the technical results of the work are published.

[2] Morrell's Voyages, 1822-31, Capt. Benjamin Morrell, 1832, p. 69.

The Protection of Iron and Steel by Paint Films*

The Problem of Preservation to be Solved is Physical Rather Than Chemical

By Norman A. Dubois

THE theories of corrosion of iron and steel which have received consideration and which still seem to have their defenders and opposers are interesting to note. The carbonic acid theory in brief requires the presence of carbonic acid to start corrosion. The peroxide theory supposes that hydrogen peroxide is formed in the presence of moisture and oxygen, and that this hydrogen peroxide causes corrosion. The electrolytic theory assumes that iron passes into solution in water in the form of a ferrous ion before it can oxidize. A more or less complete discussion of these theories may be found in the various journals and other publications. It is not the purpose of this paper to discuss them.

From the standpoint of the paint technologist the problem is that of finding the paint film which will enable him to protect the exposed surface of iron and steel from the various rusting influences for the longest possible time. The theories of corrosion and numerous discussions of them have been of inestimable value, and the proper interpretation of them has enabled the paint technologist to improve his paint film. Let us briefly consider these theories from the standpoint in question.

The carbonic acid theory requires the presence of carbonic acid that corrosion may proceed. In other words, considering a paint film properly applied over the surface of iron and steel it requires that carbon dioxide shall pass through this film, and also that water, either as such or in the form of aqueous vapor, shall pass through the film, and there in conjunction with the carbon dioxide react as carbonic acid. The imperviousness of the paint film to carbon dioxide gas and to aqueous vapor, then, is the vital quality from the standpoint of this theory. The more impervious the paint film to the gases carbon dioxide and aqueous vapor, the longer it will protect the iron or steel from corrosion.

The peroxide theory requires the formation of hydrogen peroxide on the surface of the iron or steel. Considering a paint film properly applied over the surface of iron or steel, therefore, this means that the less pervious the paint film is to the gases oxygen and aqueous vapor, the smaller will be the quantity of hydrogen peroxide formed on the surface of the iron or steel, and the longer it will protect the iron or steel from corrosion.

The electrolytic theory requires that iron first passes into solution in water as ferrous ion, and that it is then acted upon by oxygen dissolved in the water or by carbon dioxide and water to form rust. Again considering a paint film properly applied over iron or steel this theory requires the presence of water in which the iron may dissolve to form ferrous ions. Obviously, the only way the water can get to the iron or steel is to pass through the paint film, as such, or in the form of aqueous vapor. If we suppose the ferrous ions have been formed, the action can go no further in the absence of an oxidizing agent, presumably oxygen, which in turn must get through the paint film. The reasoning for the presence of other gases is similar. We find, therefore, that for corrosion to proceed according to the electrolytic theory the gases, aqueous vapor, oxygen, or others must pass through the paint film, and as in the other cases, the more impervious the paint film to gases and moisture, the longer it will protect the surface of the iron or steel from corrosion.

This is but to conclude that the paint film which will serve for the longest time as a protection to iron or steel against corrosion is the one which is the least pervious to aqueous vapor, the gases oxygen and carbon dioxide, or in fact any gas in the surrounding atmosphere which may in any way cause or accelerate corrosion.

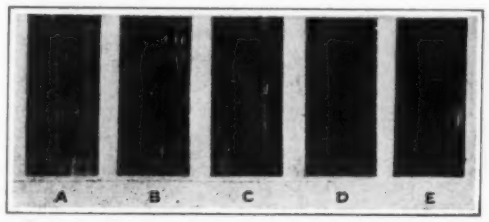


Fig. 1.—Steel panels painted with paints of same formula except one constituent of the vehicle.

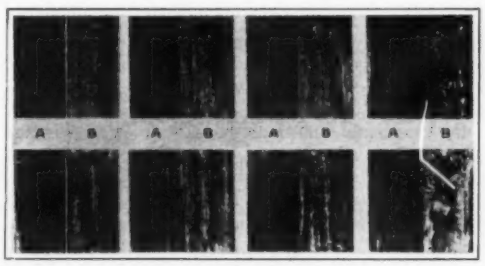


Fig. 2.—Pairs of steel panels.

A's primed with special red lead paint. *B's* primed with usual red lead paint. All painted with same second coat paint.

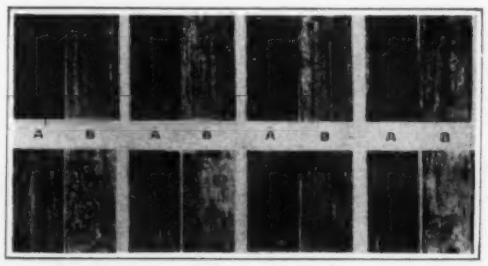


Fig. 3.—Pairs of steel panels painted with so-called rust-proof paints.

A's primed with special red lead paint. *B's* primed with rust-proof paint. All second coats of rust-proof paint.

If we assume the corrosion to be entirely due to the deterioration of the paint film rather than to its permeability to aqueous vapor and other gases, the same conclusion holds, as the rate of deterioration will be proportional to the permeability of the film to the deteriorating elements.

The electrolytic theory of corrosion has given rise to a division of pigments into three classes: corrosion accelerators, corrosion inhibitors, and inerts. While these pigments seem to give results as predicted by this theory in the presence of abundance of water or when the iron or steel is actually immersed in water, it does not necessarily follow that they will do so, to a like extent at least, when incorporated in a paint film where conditions are much different.

Assume, for instance, that our paint film is somewhat pervious to aqueous vapor and other gases. It follows that just as moisture may enter to the iron or steel surface and perhaps give conditions under which the electrolytic theory may apply when outside conditions are damp, this moisture may also pass from the steel surface outward when outside conditions are dry, and thus leave the steel surface dry, in which case the electrolytic theory cannot possibly apply. As a matter of fact, the actual conditions existing on the surface beneath the paint film, in most instances, are very probably between the two extremes of somewhat damp and nearly dry, and this is far from being covered with an abundance of water at all times, the conditions under which the electrolytic theory seems to work out well. This reasoning is borne out by the fact that a piece of bright steel immersed in water containing a little zinc chromate in suspension will remain bright perhaps indefinitely, while the same pigment in a paint film under ordinary conditions will not protect the steel in a like manner.

Again, two paints composed of the same vehicle, but the first containing a so-called corrosion accelerator only, painted on a steel surface in a locality of ordinary dryness, will outlast to a great extent the second containing a rust inhibitive pigment painted on a steel surface in a locality habitually very damp.

This reasoning seems to indicate and the evidence seems to bear out the conclusion that the problem of iron and steel preservation is rather to be solved by making our paint film as nearly impervious to gases as possible, than by trying to prevent corrosion by the addition of the so-called inhibitive pigments.

The problem is a physical one rather than a chemical one, and a comparison of paint films as to their relative obstruction to the diffusion of gases will tell more regarding their value as protection against corrosion than a study of the inhibitive action of their pigments. This is not to say that the inhibitive property of certain pigments is not worth consideration, but the imperviousness of the films is of far greater importance.

The work to be described here was carried out for the purpose of determining whether a special formula paint made according to the foregoing principles, embodying diffusion retarders, would not outlast in protecting qualities those made according to the formulæ accepted as first quality paints for their respective purposes.

Our prime object is to make the film as impervious to gases as possible. This may be accomplished to a cer-

*Reproduced from the *Journal of Industrial and Engineering Chemistry*.

tain extent by special treatment of the vehicle and by incorporating special pigments and pigment combinations. It is well known that a film from the oxidation of pure linseed oil, i. e., a film of linoxin, is more or less permeable to moisture and gases. It is more or less porous. If other oils or gums, or similar materials, can be incorporated with the linseed oil to form a homogeneous mass which as a whole acts as a perfect vehicle as regards compatibility of properties, it is readily understandable that such treatment may, to an extent, fill the intermolecular spaces between the linseed oil molecules, just as in other cases of solution, alloy, or mixture; and this compound vehicle will be more dense, will leave a film which offers more resistance to the diffusion of gases, and will, therefore, protect the iron and steel for a longer time (assuming other things equal) than a film which has not been treated in this way.

Fig. 1 shows five steel panels which, after thorough cleaning with hot 10 per cent solution of sulphuric acid for twenty minutes, washing by immersion in dilute caustic solution, thoroughly washing with water, and quickly drying, were painted as follows. All paints were of the same formula, with the exception of one constituent in the vehicle.

Panel A is a pure linseed oil vehicle.

Panel B contains 5 per cent of Kauri mixing varnish in the vehicle.

Panel C contains 10 per cent of Kauri mixing varnish in the vehicle.

Panel D contains 20 per cent of Kauri mixing varnish in the vehicle.

Panel E contains 30 per cent of Kauri mixing varnish in the vehicle.

These were exposed in a closed box with a glass front, in order that the conditions could be carefully watched. Oxygen and the corrosion accelerating gases in the atmosphere were passed into the box through wash bottles, to insure a slow but steady current, and a small quantity of steam was admitted to keep the atmosphere within the box always very moist, but not sufficient to raise the temperature materially. The panels were examined from day to day, and removed when it was judged that further exposure might obliterate the truths for which we were seeking.

It is very evident that the panels at both ends have failed before those between. A relation may also be seen between the duration of protection and the quantity of Kauri mixing varnish in the vehicle. The protecting qualities increase with the per cent of Kauri mixing varnish to a certain point, and then fall off again as the percentage of Kauri mixing varnish is increased beyond this point. This seems to indicate a definite point of maximum sealing effect for this particular material.

Another illustration of making a paint less pervious and therefore a better protection against corrosion, is the proper choice of pigments. Red lead and linseed oil have been long looked upon as the best primer for iron and steel. This may be true, but is it not possible to improve this red lead and linseed oil without seriously changing its nature and obtain a film which is less pervious to gases and moisture and thereby protect the iron and steel even more effectively than will the red lead and linseed oil? If we shake off some of the traditional bonds and apply the teachings of more recent scientific investigation we find it possible by using the foregoing principles and the proper choice of particle sizes, making use of the law of minimum voids, to produce a red lead primer, which has all the advantages of the traditional red lead and linseed oil, and is at the same time less pervious, and therefore a better protection against corrosion.

Fig. 2 shows a series of pairs of steel panels, which have been cleaned in the usual manner with acid, etc. Both *A* and *B* of each pair were painted with the same second coat paint, and each pair with a different second coat paint, while *A* of each pair was primed with a special red lead paint, formulated according to the principles just mentioned, and *B* of each pair was primed with red lead and linseed oil mixed according to a formula considered to give the best results obtainable after many years of practical painting under more or less adverse conditions of moisture and corrosion accelerating gases. All the panels were painted in exactly the same manner on the same day, allowed the same time to dry between coats and also after the second coat, and exposed as previously described at the same time and for the same length of time. Since the second coat on *A* and *B* is the same in each instance its effect has nothing whatever to do with the comparison, this being dependent entirely on the difference in the red lead priming paints on *A* and *B*. It can be seen at a glance that the special red lead paint on *A* has given a much more efficient protection than that mixed according to the prevailing custom on *B*. One hundred and twenty comparison panels were exposed in this test and in every instance panel *A* showed a better film than did panel *B*.

Lastly, let us take up for a brief space the incoming of the throng of fantastically named "paints" which have been put on the market with claims equally as fantastic. Many of these have been claimed to protect the iron and steel as a primer and as a second coat better than anything on the market. It is only necessary to refer to Fig. 3, which is a photograph of some pairs of steel panels prepared as before mentioned and painted with a number of so-called rust inhibitive or rust proof paints. On panels marked *B* was painted two coats of a paint, and on panels marked *A* one coat of the same paint over a priming coat of the special red lead paint formerly mentioned. As a different paint is on each pair there are as many different paints as there are pairs of panels.

It is readily seen that the two coats of any of these paints, *B*, do not protect as well as where it is applied over the special red lead primer, *A*.

Blue lead seems to have certain properties very similar to red lead when used in a paint for the priming of iron or steel, and in fact it is very possible that it may be fully as good for this purpose as red lead, when properly used, if not better. Experiments are now being conducted by the writer to determine these relations.

Recently the idea has been set forth that certain pigments are rust inhibitive by virtue of their alkaline qualities. Further investigation seems necessary to determine whether it is simply the alkaline properties of these pigments considered as a rust inhibitive only which endows the paint film with thoroughly superior protecting qualities.

The suggestion may not be out of place that the basic properties of certain pigments enable them to attack the vehicle to a sufficient extent to form a small quantity of metallic soap which acts as a binding material between the pigment particle and the linoxin, thus offering a greater obstruction to the passage of disintegrating elements between pigment particles and vehicle; or perhaps acting as a diffusion retarder in the linoxin.

It is not the intention of the writer to point out the shortcomings of any particular brand of paint or theory, but simply to give results of experiment and interpretation of the same with a view to bettering the paint conditions for all concerned.

In conclusion then, it would seem that whatever the correct theory of corrosion may be, it is of first importance to the paint technologist to construct his film in such a manner as to exclude gases and moisture to the greatest possible extent, as without these no corrosion can possibly take place.

Labor Classified on a Skill-Wages Basis*

A Plan for the Equitable Adjustment of Wages Inaugurated by the Ford Motor Company

By O. J. Abell

In the automobile industry at Detroit, the proportion of floating or transient help has been little short of amazing. The maintenance of a required force of men has necessitated in consequence a continuous hiring process involving numbers greatly in excess of the normal pay roll. One large manufacturer of automobiles found it necessary in 1912 to hire a total of 20,000 men in order to maintain an operating force of less than half that number. In the present year the situation has improved somewhat, but in the past this shifting about appears to have been quite independent of business conditions and no assurance is felt that a permanent stability is at hand. The expense created by this hiring of new men is enormous, the more oppressive because it is an unproductive outlay. Another builder of motor cars has estimated that the time required to hire a man and deliver him to the department in which he is to be employed is 2 hours 10 minutes. On the basis of 30 cents an hour, this is an expenditure of 65 cents, or for the hiring of 5,000 men a month—not an unusual experience—an expense of $3,250, equivalent to a yearly cost of nearly $40,000.

The explanation for this instability of labor is in part obvious. The rapid growth of the automobile industry brought all classes of labor to Detroit from all parts of the country, both because of special inducements and in response to the natural appeal made by higher wage scales. Naturally the men most inclined to shift about were the ones who shifted to Detroit. Then, too, the seasonable variation in the operations of many of the plants contributed its influence to the general unrest, so that plants which have operated uniformly throughout the year fared no better than the others. Increases in wages which gave to the employee as much for 9 hours as he could earn at other plants for 10 hours, plus his carfare and a little more, were equally unavailing. Plainly the opportunity for steady employment at good wages and under working conditions above the average in point of sanitation, safety and physical comfort, was not in itself sufficient incentive for holding a job. And in this fact there is much to think about. It is a significant and interesting commentary upon the psychology of the average shop hand, a side light on the extension of welfare work in industry.

Recognizing this much of the problem, the Ford Motor Company has undertaken to make continuous employment in its plant appeal to the men. (1) By satisfying each employee that he is being paid all to which his productive ability and period of service entitles him, both in dollars and cents and in comparison with the other men about him. (2) By making it possible for every employee to secure funds practically whenever he needs them without inconvenience and at a normal charge. The first is to be accomplished by the classification of all employees under a fixed scale of wages

Table 1. Classification of Employees and Wage Schedule Made Effective October 1, 1913.

A—Mechanics and sub-foremen.
B—Skilled operators.
C—Operators.
D—Helpers.
E—Laborers.

Service—Employees in service continuously for two years and over.
1—First class workmen.
2—Men of average ability.
3—Beginners.

Skill Rate	Present Hiring Rate	New per Hour Rate	Rates Ranging	b-c	d-e	g-h	k-l	n-o	p-q	r-s	u-v	w-x	y-z
			Condensed to	a	c	f	i	m	n	p	t	u	w
A—xx				2	7								
A—x													
A—1		f				2							
A—2		i					45						
A—3		m						273					
B—Service		m						51					
B—1		n							606				
B—2		p								1457			
B—3	w	t									1317		
C—Service		n							19				
C—1		p								348			
C—2		t									2071		
C—3	w	u										4311	
D—1		p								31			
D—2		t									137		
D—3	w	u										416	
E	w	u										2003	
Special	y	w											208

* Reprinted from the *Iron Age*.

according to productive ability and length of service, and the second, through the establishment of an Employees' Savings and Loan Association.

Both undertakings were placed in operation October 1st. At the end of one month's trial a comparison was made with the month of December, 1912, a typical month under the former system. The facts developed are indicated as follows:

	December, 1912.	October, 1913.
Five-day men	3,594	322
Men discharged	776	137
Men quitting	386	326
Men laid off	4,822	844
Total hired	5,678	1,789
Gain for the month	856	945

In this statement the 5-day men constitute the typical floaters. Making full allowance for changed business conditions, this comparison still is most astonishing. While the showing of this one month is not considered as conclusive the coincidence is striking, the more so for the reason that the preceding months of 1913 were about the average months as represented by the December figures above.

Th skill-wage classification was worked out from a general survey of the entire operating force. Direction was given to this survey by the following considerations:

1. Justice as against discrimination for all employees.
2. The reduction to a minimum number of all the different rates of wages paid.
3. The establishment of a well regulated systematic schedule for increasing wages of individual employees by certain fixed amounts.
4. The classifications of all employees according to their skill.
5. A classification according to the term of service.

For a standard with which to compare the individual skill of each operator the established shop rate of the plant was taken. This shop rate for any particular operation is derived from the machine production as rated by the manufacturer less a percentage deduction for the human element and the necessary stoppages of the machine. For each operation in the shop the human equation has been based on the best possible production of a skilled employee determined by actual trial. Comparing the production of any employee, in making this survey, with the shop rate, it was possible to place his skill relatively in the scale. The observations made resulted in the establishment of six general classes or planes of work indicated alphabetically from A to E with one special class, as graphically shown in Table I.

CLASSIFICATION OF WORK.

A—Mechanics and sub-foremen.
B—Skilled operators.
C—Operators, such as ordinary press hands, drill press operators, etc.
D—Helpers.
E—Laborers and non-productive workers.
Special—Girls and messengers.

These several classes were then graded as regards skill into three subdivisions based on the shop rating.

1. Meaning good.
2. Meaning fair.
3. Meaning medium and beginners.

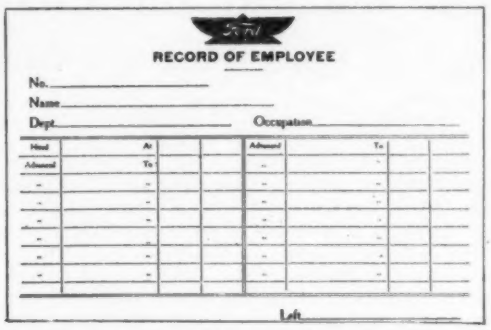
Thus the designation C-2 indicates, for example, a machine operator of fair skill.

Prior to the inauguration of this new system there were paid in the shop a large number of rates of wages varying from 22 cents per hour to 60 cents per hour. All of these rates were condensed into but 10, as indicated in Table I. As there were but nine employees earning above 50 cents an hour there are practically but eight rates now in operation. In adjusting the wages to the new system every employee was advanced. For example, in a group with wages included between the limits of 23 and 25 cents per hour, the 25-cent man receives 26 cents, up to which rate the 23-cent man is also brought.

Some complaint was made by the former employees, but it was demonstrated in practically every instance that within the narrow range of each of these wage subdivisions the men who were getting the smaller pay simply had been less fortunate in making their worth known or had been less favored by the foreman, and such pains were taken to demonstrate this fact to the men receiving the higher wage that no possible ground was left for complaint. The attitude of the company was also very clearly put before the men in that the company expected the operators to advance from one class to a higher and that if they did not inquiry would be made regarding the reasons therefor.

As applied to the beginners in particular the company anticipates that the employee should be entitled to an advance in the course of six weeks. To check this fact, the envelope in which the records of each employee are filed in the time keeping department, are prepared with the form illustrated in Fig. 1, suitable for noting each wage advance that the employee receives. Pay-days occur every two weeks. If, after three consecutive pay days the envelope shows no record of an increase the envelope is laid aside and a report is made on the blank form shown in Fig. 3. The case is then taken up with the foreman of the department in which the man is employed and an actual record secured of his work. If he is entitled to an advance and has been overlooked the increase is given him.

It is impressed upon the foremen that their departments and their own showing are handicapped by the presence of men who cannot make the expected progress. The foreman knowing that the man already employed is likely to be as capable as the next average man to be hired, thus has an incentive to help the employee as much as possible. If the workman shows

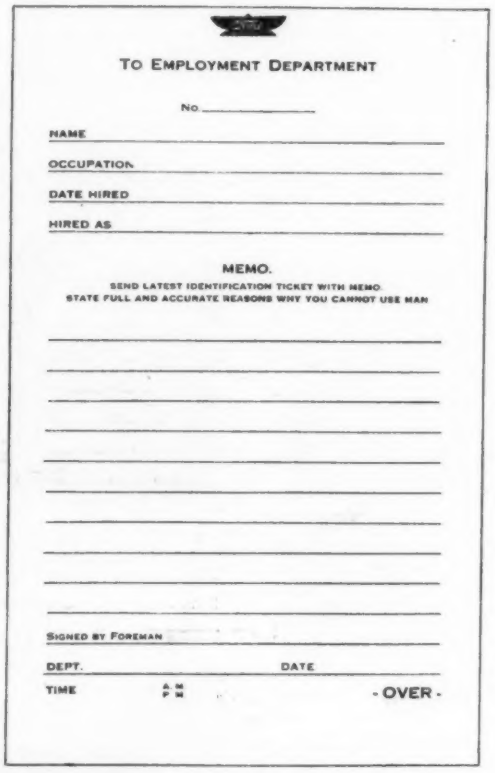

RECORD OF EMPLOYEE

No.
Name
Dept. Occupation

Hired	At			Advanced	To		
Advanced	To			"	"		
"	"			"	"		
"	"			"	"		
"	"			"	"		
"	"			"	"		
"	"			"	"		
"	"			"	"		

Left

Fig. 1.—The face of the 4 by 6-inch manila envelope for keeping the individual employee's record.


TO EMPLOYMENT DEPARTMENT

No.

NAME

OCCUPATION

DATE HIRED

HIRED AS

MEMO.

SEND LATEST IDENTIFICATION TICKET WITH MEMO.
STATE FULL AND ACCURATE REASONS WHY YOU CANNOT USE MAN

SIGNED BY FOREMAN

DEPT. DATE

TIME A M / P M

- OVER -

Fig. 2.—Blank for foreman's report on the inefficient operator.

himself unequal to the progress expected the foreman advises the employment department making out his report on the form shown in Fig. 2. This case is also investigated and it has been found frequently that an employee is better suited to work in another department, in which case he is transferred immediately.

A man is discharged only when it seems impossible to work him efficiently in any department of the shop, the general principle being that the man already hired about whom something is known is better material for further effort than the man who must be hired in his place and about whom nothing is known. It also frequently happens that a man when applying for a position overrates his own ability and it develops after he has been employed that he falls considerably behind the rate or class of work for which he is hired. This man is given the option of work he can do, at a lower wage, or of being discharged.

The plan contemplates the advance of employees from one grade of skill to a higher and also from one class of work to a more highly paid class. It is apparent, however, and is clearly shown in Table I, that the majority of the employees are included in the B and C grades. It is obvious that the number of positions to be filled thus decreases very rapidly in the more skilled classes of work, and as a result more operators are likely to make progress entitling them to be advanced than there are vacancies available. In order to reward such operators an additional rating has been inserted into the C and B grades, known as a service rate. This is intended to provide for all operators who have attained a high grade of skill and who have been in the service of the company at least two years. This also affords a recognition for the faithfulness of those operators who have acquired proficiency in their particular work, but lack ability to advance to higher grades of usefulness.

Under this system the employee can be made to understand clearly that his own wages and those of every other man in the shop depend entirely upon the work he does, that an improvement in his work will be rewarded without fear or favor by a stipulated amount corresponding to the improvement shown, and that increased production and a wider range of ability will bring about a definite advancement and a definite increase in earnings. The incentive to continuous service is equally clear.

The Savings and Loan Association, inaugurated simultaneously with the above plan, has some features different from those usually embodied in similar undertakings. The two objects of the association are stated as being the encouragement of the saving habit among the employees and the providing of a means by which employees may make small temporary loans with little expense and no loss of time. The association is governed without expense by an administration committee consisting of three men appointed by the vice-president or the treasurer of the Ford Motor Company and of such standing as to insure proper handling of the association's funds. Operating expenses are borne by the company. Membership is entirely voluntary and may be withdrawn at any time, the employee receiving a check for the full amount of his deposits. Each member is required to deposit with the association $1 each pay day, except where three pay days occur in one month, and in which case the third is omitted. The $1 is not taken out of the pay envelope by the paymaster, but is required to be deposited by the member with the individual in his department authorized to receive it. The earnings from the funds thus deposited will come from the fees made on loans to employees, from bank interest and from income resulting from investment and are to be distributed quarterly.

The loaning features of the association are perhaps the most interesting. Any employee of the Ford Motor Company, whether a member of the association or not—and it is interesting to note that most of the borrowers are not members of the association—may borrow from the association on the following terms:

$5 or less to next pay day	$0.10
$6 to $10 to next pay day	.20
$11 to $15 to next pay day	.30
$16 to $20 to next pay day	.40

A special "Loan Association" window has been set aside for the purpose, near the time clocks in the paymasters' shop office. These loans are secured by a receipt form signed by the applicant when he receives his money, which form constitutes an order on the paymaster to deduct the amount of the loan from the next pay of the borrower. Loans may be applied for not often than once between pay days and cannot exceed $20, except by special arrangement with the administration committee. In the evening when leaving the shop, the employee turns in at the association's window his time card with the notation on it of the amount he wishes to borrow.

From this notation and the time card, the time on the books to the man's credit can be located. If this covers the loan requested a receipt form is made out for

DEPARTMENT FOREMAN

Man Number	Name	Sub-Foreman	Machine	Class of Work	T-No	No. Pos.	No. Pos.	Date Hired	Pres. Rate	Foreman's Remarks	Remarks

Fig. 3.—Blank for recording performance of backward operators.

the employee to sign and the cash is handed over to him without question. He is required to identify himself by the display of his employee's badge which bears his clock and time card number, and which all employees are required to wear in order to gain entrance to the plant each day.

This borrowing privilege is used freely and a long line of men avail themselves of it each night. The loaning does not involve the advancing of wages not yet earned, but confines the loans within the time already on the pay roll. An observation of the type of men generally making up the borrowing line seems to point clearly to the fact that these men are largely of the improvident and undependable type normally comprising the shifting class of labor. In their philosophy such an institution fits most conveniently. It is, therefore, reasonable to expect that this plan in operation will exercise some hold upon them. The period of operation has not yet been of sufficient length to indicate to what extent the same men repeatedly use this privilege, nor is it demonstrated to what extent this borrowing is occasioned by real need as against careless improvidence, although numerous instances have already come to light where misfortune has thus been greatly lightened. After an employee has made three loans he is questioned closely in order to discover whether the borrowing has a basis in real need or not, and investigations thus far have shown a preponderance of deserving cases. In some respects this plan which makes it so easy to secure money may have the appearance of catering to the undesirable element in the shop, but if it results in creating a habit of steady employment and continuous service, it may also develop other traits of manual improvement and character that naturally are expected to associate with steadiness in any direction.

The Car Ferry in Freight and Passenger Service

Its Evolution From a Mere Float to a Veritable Liner

By Harry Chapin Plummer

RAILROAD managers of the United States are manifesting considerable difference of opinion on the question of the utility and safety of the car ferry for freight and passenger service. There have lately been effected some important changes in the plan of car transfer across bodies of water that break the continuity of trackage of leading American trunk lines or provide a short cut to and from connecting lines.

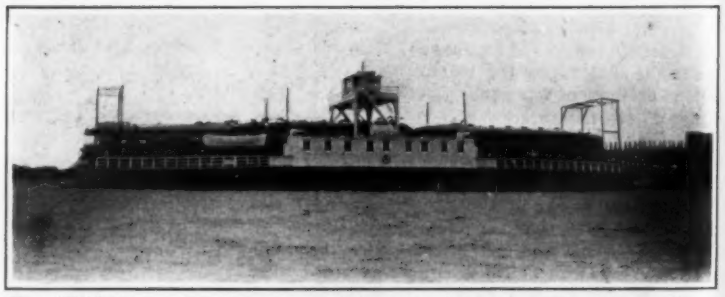
Perhaps the most notable of these changes was the sudden abandonment of the New York, New Haven and Hartford Railroad car ferry service around Manhattan Island, New York city, from Jersey City to the Harlem River terminal, and well in advance of the completion of the Hell Gate Bridge and the Brooklyn, Narrows and Staten Island subway system which were designed to ultimately dispense with the need for the ferry steamers "Express" and "Maryland," of well nigh historic fame. Another was the resumption of the car ferry long in operation by the Baltimore and Ohio Railroad between Locust Point and Canton, on opposite sides of Baltimore harbor. The significant feature of the reinauguration of this service with craft and ferry approaches of the most modern equipment is the fact that the undertaking has been made to relieve congestion of traffic on the belt-line of railway which tunnels the Maryland metropolis and which was constructed at an enormous cost to succeed the Locust Point-Canton ferry formerly in operation. Of less recent date was the closing of the Northern Pacific Railway's car ferry across the Columbia River, from Kalama to Goble, in the State of Washington, following the completion of a 6,468-foot bridge across the stream noted for its salmon yield, on the route between Portland, Ore., and Vancouver, Wash., in which the car ferry was an important link. The retired steamer "Tacoma" was 320 feet in length, 73 feet wide, and of a gross tonnage of 1,362. Her engines were of 1,000 horsepower and her average speed was twelve miles per hour.

As showing the indispensability of the car ferry under certain and often formidable conditions of navigation, it should be observed that the Pere Marquette and the Grand Trunk railways not only continue to operate their services on the Great Lakes, where ice and storm render operation exceedingly difficult, if not hazardous, in the winter time, but endeavor to have

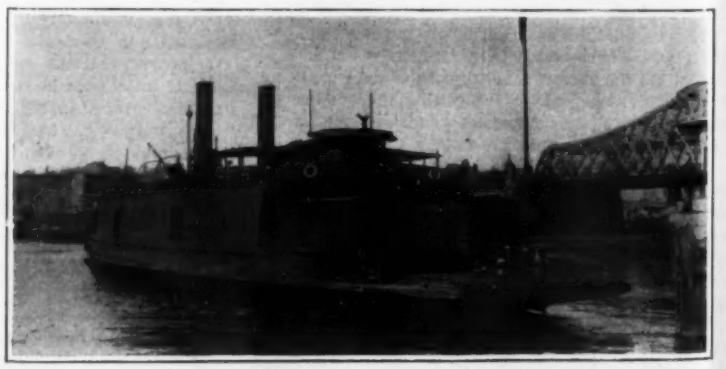
Southern Pacific Railroad car ferryboat "Solano," familiar to transcontinental travelers, which long has operated on the Sacramento River as a link in the old Central Pacific route from Ogden, Utah, to San Francisco.

New type of car ferry transfer bridge built for the reopened Baltimore and Ohio Railroad ferry between Locust Point and Canton in Baltimore harbor, which improves upon pontoon and steel types and better distributes the weight of loads by system of pick-up counterweights.

While being ferried across Lake Ontario, from Rochester, N. Y., to Port Coburg, Ontario, Canada, Grand Trunk Railway passengers are provided a luxurious environment, and on the same voyage a train of thirty freight cars of 1,800 tons combined weight also will be carried.



The "Bridgit," a car ferry boat driven by internal combustion engines. Length, 186 feet; beam, 57 feet; draft, loaded, 13 feet; gross tonnage, 595 tons.



Steamer "Express," which, with the "Maryland," ferried New York, New Haven and Hartford Railroad through trains in the Washington, Philadelphia and Boston Service around Manhattan Island, New York, from Jersey City to the Harlem River Terminal, for almost a quarter century.

their improvements in the construction of steamers keep pace with the physical development of the railway lines on land. The Pere Marquette ferry steamers on Lake Michigan are uniform in dimensions and capacity, being of 350-foot length, 56-foot beam, with an average speed of fifteen miles per hour.

Interest in the question of the safety and the economy of time and expense in this mode of transportation, assumes an international scope at present from the fact that it is being agitated in Great Britain and Ireland in connection with the working out of the "All-Red Route," a rail and steamship system planned to operate between London, England, and Sydney, Australia, *via* the Atlantic, Halifax and Boston, a Canadian transcontinental road, and the Pacific. When the gigantic project comes up for final shaping for parliamentary action at the Imperial and Colonial Conference in London, this winter, the problem of the car ferry will be a vital consideration. Each of several routes proposed to cross the Emerald Isle from the north, or St. Patrick's Channel, to the Atlantic, will be first weighed in the light of the safety, ease and dispatch of car ferry connection across the Channel from the English, Scottish or Welsh coasts.

The particular route through the British Isles which thus far has received the most support from influential political and financial circles of the Empire, is that projected to extend from London by direct rail line to the Scottish border town of Stranraer, near Dumfries, thence by car ferry twenty-one miles across the North Channel to the Irish port of Larne, near Belfast, and thence across the northern tier of counties to Blacksod, a remarkably fine natural harbor on the west coast.

Because of the strategic advantage of the location of Blacksod Bay as a possible naval stronghold, the Stranraer-Larne-Blacksod route has received the indorsement of high officials of the British Admiralty, including Admiral Sir Cyprian Bridge and Vice Admiral Sir Charles Campbell, both of whom have gone on record with statements advocating the establishment of Blacksod as the Atlantic terminal of the All-Red Route.

Sir William Henry White, former director of naval construction, another Admiralty official to come out in favor of the Blacksod terminal, lately advanced some interesting observations regarding the car ferry planned to operate between Stranraer and Larne, with special consideration of the great risk associated in the popular mind with the transport of railway trains by ferry. He cited the ferries maintained on Lake Michigan, in this country, where runs of from 60 to 100 miles are made, as examples of the successful employment of railway ferryboats on a large scale. Actual observation has shown, he avers, that heavier seas are encountered on the Lake Michigan service than on the route of the proposed ferry across the Channel. He adds that despite the very severe weather faced, especially during the winter, "experience with these vessels has been quite satisfactory in regard to safe and regular communication and economical transport of goods and passengers."

Pointing out that the length, bulk and weight of a modern railway train naturally produces an impression that both the operation of placing it on board of a ship and its presence on the deck when the vessel is in a seaway must involve considerable risk and must prejudicially affect the stability and behavior of a ferry steamer, he states:

"The first-class passenger train *de luxe* of modern type, providing accommodation for more than 400 passengers, weighs less than 350 tons, exclusive of the engine and tender, which would not, of course, be ferried,* and has a total length of 650 feet. Broken up into two parts during transit, it would be distributed over a length of more than 300 feet and be carried at a moderate height above the water.

"The naval architect is accustomed, especially in warships, to deal with much greater weights carried in a more concentrated form and at much greater heights above the water. For example, in a battleship the armored stations, the gun mountings and loading appliances for a pair of 13-inch guns, the guns themselves and the armored shield protecting them, would represent a total weight of more than 1,000 tons. This great weight would be concentrated in a length of about 30 feet, and the guns could be carried at a height of 25 to 30 feet above the water.

"Careful design is admittedly essential in regard to appliances for embarking and disembarking trains. On the coast of Great Britain and of Ireland, where there is a great rise and fall of tide, arrangements are required which are not necessary in non-tidal water, because of the varying heights of the fixed land approaches above the deck of a ferry steamer, at different stages of the tide. . . . In practice the fulfillment of these conditions presents no insuperable difficulty of an engineering nature, although the choice of the ferry stations at the terminal ports must be greatly influenced by consideration of the points mentioned."

It is understood that the range of tide and variation in height of ferry landings in New York harbor, which, while not so remarkable as in British waters, are yet more of a factor than elsewhere on the Atlantic coast of the United States, except at Boston and Portland, Me., operated as much against the successful loading and unloading of the New York, New Haven and Hartford Railroad ferry transfer steamers at Jersey City and the Harlem River Terminal as against the navigation of those vessels on the congested waterways that encircle Manhattan Island. Aside from the consideration of tide, the matter of ice was in the winter a drawback in the placing of trains aboard and off the steamers and in the entering and backing out of the landing-slips.

The loss of time in the transfer of the "Federal" and "Colonial" express trains, running between Boston and Washington, which devolved upon the steamer "Maryland," and the frequent "close shaves" experienced by both the "Maryland" and her sister ship, the freight carrier "Express," on their runs through the Hudson, the East and the Harlem rivers, which only the skill and the resourceful intrepidity of their commanders prevented from developing serious consequences, determined the New Haven officials in abruptly terminating the service.

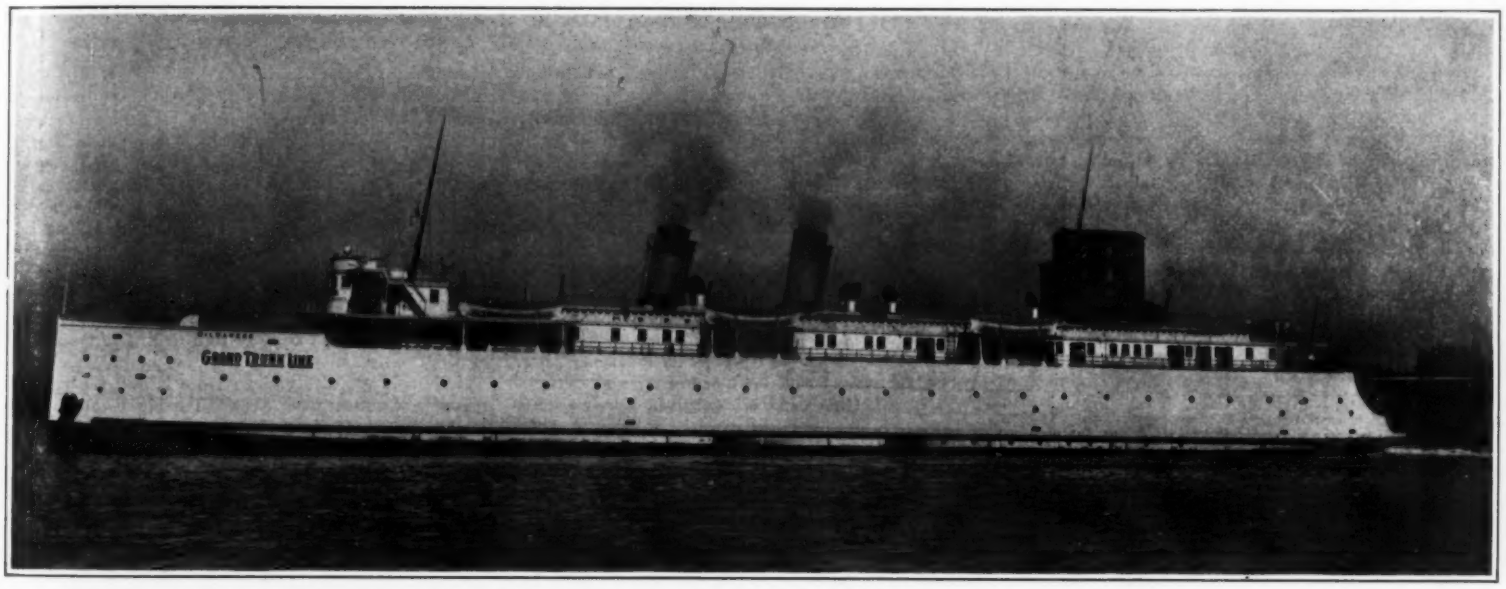
The through passenger and freight service hitherto performed by the Washington-Boston trains was, accordingly, routed *via* Trenton, N. J., the Belvidere Division of the Pennsylvania Railroad and northern connections, the Poughkeepsie bridge across the Hudson River and the old Central New England Railway, now operated by the New Haven road into Hartford. This alternative had long been available to the trunk lines interested, but it had been anticipated that the completion of the Hell Gate Bridge and the subway loop through three boroughs of Greater New York would obviate the necessity for resort to it.

Owing to the crowded traffic conditions in New York harbor, the "Maryland," which was 238 feet long, 38 feet wide and 13 feet deep, with engines of 1,250 horsepower, seldom exceeded a speed of fifteen miles per hour on her 11-mile runs between Jersey City and the Bronx, while the heavier laden freighter "Express," which was 272 feet long, 44 feet wide and 12.6 feet deep, with engines of 1,000 horse-power, was obliged to keep to an even lesser rate of speed.

Over the car ferry which the Baltimore and Ohio Railroad is to reopen there must pass almost the entire volume of a traffic which makes the port of Baltimore the foremost corn exporting point in the United States. There are annually shipped from the big city on the Chesapeake, 40,000,000 bushels of corn and 20,000,000 bushels of other grains, while the flour traffic has a yearly aggregate of 3,500,000 barrels. This formidable movement centers at Locust Point, where are located the Baltimore and Ohio freight yards and grain elevators.

In Baltimore harbor the range of tide and consequent variation in the height of car floats is not nearly so great as in the waters surrounding New York city. This condition has favored the evolution of a new and distinct type of transfer bridge to insure the safe, expeditious and economical passage of trains to and from the steamers, which are to be of the most improved and up-to-date construction. The new bridge is 51 feet 1 inch in length from the hinge at the land end to the water end, and consists of two single-track through plate girders, one span supporting each track. The land end of these girders is hinged around a 5-inch pin. To overcome the settlement of the outer end as the live load comes onto the span, there has been provided a system of pick-up counterweights—flat cast-iron sections chained together—which, as the bridge settles with the coming on of the live load, comes into action and takes up the live load reaction of the bridge at the water end that naturally would come on to the barge were the counterweights not provided. Two tilting heads, pinned at the center, to which the barge is rigidly attached by means of toggle bars, relieve the bridge structure of the warping and twisting experienced when one track is supporting a load and the other side is idle, that is a pronounced disadvantage of the pontoon type of transfer bridge long in use. The steel structures with flexible timber aprons in use about New York have been designed to eliminate the pontoon, which develops serious drawbacks in freezing weather, when the ice masses wedge beneath it and throw it out of plumb.

The half-million dollar ferry steamers plying in the Grand Trunk Railway service on Lake Michigan, between Grand Haven, Mich., and Milwaukee, a distance of 64 miles, and on Lake Ontario, between Rochester, N. Y., and Cobourg, Ont., a distance of 56 miles, are noteworthy examples of the evolution of the car ferry from a mere float to a veritable liner that combines the appointments of a first-class passenger steamship, including grand saloon, retiring rooms, staterooms and restaurant, with a miniature floating freight yard. Of



Plying between the Wisconson metropolis and Grand Haven, Mich., on Lake Michigan, the 350-foot Grand Trunk Railway ferry steamer "Milwaukee" combines the speed, safety and passenger appointments of an ocean liner with a miniature floating freight yard.

* A train of thirty cars loaded with coal, and totaling in weight 2,400 tons, is not an uncommon shipment on the ferry steamers of the Pere Marquette Railroad, on upper Lake Michigan.

the two steamers performing the service on Lake Michigan, the "Grand Haven" is the speedier, while the "Milwaukee" is the larger. The former has a length of 320 feet over all, breadth of beam 54 feet 4 inches, and a depth of hull of 17 feet 3 inches, with engines of a capacity of 4,000 horse-power, and attains to a speed of 20 miles per hour. The latter is 350 feet in length, has a breadth of beam of 56 feet, depth of hull of 19 feet 6 inches, has engines of a capacity of 3,000 horse-power, and she accomplishes a speed of 17 miles per hour.

The absence of tides and of varying elevations of water level renders very simple the matter of taking on board and discharging passenger freight trains in the Lake Michigan and Lake Ontario services.

The ferryboat "Bridgit" is owned by the Oakland, Antioch and Eastern Railway, and is to be used as a connecting link in its line from San Francisco to Sacramento, California. She is the largest boat of her type that has ever been constructed, and strangely enough, her run will be very close to that of the ferryboat "Solano."

The "Bridgit" was constructed in San Francisco, the hull being of wood. The most noticeable feature is the entire absence of carved frames and ship's knees, all the frames being built of straight sticks and securely fastened by drift and screw bolts. The ends of the boat are extremely flat, so as to present a large area of displacement to obviate tipping when loading or unloading cars. When loaded with four freight cars on one side, totaling 360,000 pounds, the maximum deflection is less than four degrees. There are three tracks, each accommodating three passenger coaches. The crew's quarters are on deck, and there is also a luncheon counter, where passengers may obtain light meals while crossing.

The boat is provided with two transverse watertight bulkheads, and two longitudinal bulkheads on either side of the engine room, thus insuring against end or side collision. Steering is accomplished by means of a pneumatic steering gear, air being obtained from tanks supplied by the air pumps on the main engine. A hand controlled steering gear is provided in case of emergency.

The main engine is an eight cylinder 500 horse-power distillate engine. It is placed in the center of the boat, and is connected to propellers at either end, through two disk clutches and spur gear type reversing gear, so that each propeller may be used independently of the other, either for ahead or astern. The most distinctive features of the engine are the open cross-head cylinders and the inlet manifold.

The engine is started by means of compressed air, which is admitted to the cylinders through a distributing valve driven from the crankshaft. The normal speed of the engine under full power is 200 revolutions per minute, but for maneuvering or when running idle, the speed may be reduced to 45 or 50 revolutions per minute.

In addition to the main engine, an electric lighting and pumping set is located on one side of the engine room. The speed and direction of rotation of the main engine is shown in the pilot house by means of a hydraulic speed indicator, thus enabling the captain to tell at a glance just what the engines are doing.

The engine room force consists of one engineer only, which is a considerable reduction in the number of men that would be required for a steam installation of equal capacity. The greatest saving, however, is the elimination of all fuel expense while the vessel is tied up in the slip between runs, and this was one of the main reasons for installing distillate engines, instead of steam, in this vessel.

The operation of the "Bridgit" has been entirely successful in every way, and, notwithstanding tides running with velocities of five and six miles per hour, she is handling without difficulty loads of 350 to 400 tons.

Progress of the Safety Movement*

A Review of Work Done to Prevent Accidents and to Promote Health in the Industries

By Mancius S. Hutton

It has been estimated by conservative competent experts that 35,000 workmen are killed and 2,000,000 injured, and that there are 3,000,000 cases of sickness due to occupational diseases among the industrial workers in this country each year. It is known that between 50 and 60 per cent of this economic and social waste is preventable by proper means. It is in those States which have passed workmen's compensation laws that there is the greatest progress in the promotion of safety and sanitation. At the end of the year 1913 the following twenty-two States have passed such laws:

Arizona,	Michigan,	Oregon,
California,	Minnesota,	Rhode Island,
Connecticut,	Nebraska,	Texas,
Illinois,	Nevada,	West Virginia,
Iowa,	New Hampshire,	Washington,
Kansas,	New Jersey,	Wisconsin.
Maryland,	New York,	
Massachusetts,	Ohio,	

The laws in these different States are not alike, some being more drastic than others. Some apply to all workers, others apply only to those working in hazardous enterprises which are specified. All these State laws are elective, as explained later, with the exception of Arizona, California and Ohio, which are compulsory. In the elective States the employer has the choice of voluntarily accepting the provisions of the act or of working under the common law; in the compulsory States he has no such choice. In order to make the law attractive to the employer, all the States which have already passed workmen's compensation laws and some that have not done so as yet, have changed or stricken from the statute books the old common liability law defenses called the "fellow servant" rule and the "assumption of risk" doctrine. By the fellow servant rule is meant "that the injury was caused by the negligence of another employee engaged in the same employment," and by the assumption of risk doctrine is meant "that the employee assumed the hazard of the occupation." In the past the employer has, in 75 per cent of the cases, by using either or both of these defenses, defeated any suit which the injured employee might institute in court to recover damages due to an injury. In addition, the amount of compensation for any injury has been definitely specified. In Maryland, Massachusetts, Ohio, Oregon, Texas, West Virginia and Washington, the employer is required to insure his men against casualty with a State insurance board or in one of the insurance companies which the State allows to receive such insurance. The employer pays the premiums. In ten States "Industrial Accident Boards" or commissions have been created to administer these laws.

The United States Government has already passed laws which compensate for injuries and death for about a quarter of its 400,000 civilian employees. There will be presented to Congress during this session a compensation bill which will take care of all these civilians. This bill, which will be introduced by Senator Kern of Indiana, provides for compensation for sickness or death due to occupational diseases as well as accidents. During 1914 there will probably be one State, at least, which will pass a compensation law, and two other States which will change their present laws. Besides providing for adequate and prompt compensation for accidents to industrial workers without the necessity of going to court, fifteen States have taken steps to study the question of occupational sickness among wage workers in the different trades, by requiring physicians to report to a State board or department cases of certain occupational diseases which they may be treating. In the near future these and other States will incorporate occupational diseases as well as accidents in their compensation laws. It has been found on investigation that lead-poisoning lurks in 150 different trades.

In the twenty-two States previously mentioned, laws have been passed which have increased and bettered the State inspection department, given the inspectors more power, increased the punishment imposed for violations of the laws besides requiring certain definite protection to be given to the workers in several of the trades. Where the State has an accident board or commission, the law-makers have delegated the prevention end to such board or commission by means of executive orders instead of enacting individual laws.

Active work in the prevention of mine accidents has advanced since the formation of the Bureau of Mines of the Department of the Interior in 1910. There are about three thousand miners killed every year, of whom only 15 per cent are killed in the large mine disasters which get into the daily papers. About 75 per cent of the miners in this country are ignorant foreigners. The investigations which the bureau has carried on during the last four years, have been helpful both to the owners and miners. These investigations have been published by the Government and can be obtained free upon request. The bureau has taught miners and mine officials how to carry on rescue work in gaseous mines, how to fight mine fires, and how to give first-aid to injured workers. The Government has in operation, at the present time, six mine-safety stations and seven mine-safety railway cars, both fully equipped as regards breathing apparatus, fire-fighting apparatus and materials for first-aid to the injured. These are presided over by a mining engineer who has under him a corps of highly-trained miners. Up to the present 7,734 miners have been instructed in the carrying on of rescue work with the use of breathing apparatus, in the fighting of mine fires, and the giving of first-aid. Safety lectures have been delivered to 71,500 persons by employees of the bureau. Once a year rescue and first-aid teams from various mines compete for different prizes which are offered by several of the mine companies.

For the last twenty-four years the Interstate Commerce Commission has been collecting statistics of accidents from the railroads doing interstate business. These statistics show that during that period 188,037 persons have been killed and 1,395,618 injured. These persons can be divided into three classes: First, the employees of the railroads; second, passengers; third, "other persons," including trespassers on the tracks. The "other persons" are by far the most numerous, being about 62 per cent of the whole number of those killed. Of this 62 per cent, about 85 per cent can be classified as trespassers. The reports of the commission show that a large majority of these trespassers were killed and injured at other points on the track than at the highway crossings. The eliminating of grade crossings, the stationing of gate and flagmen at the crossings, has and will in the future lessen the number of accidents at these points. One of the greatest problems which the railroads and commissions will have to face will be the question of reducing these trespasser accidents. It is the collisions and derailments in which passengers are killed or injured which get into the front pages of the newspapers, but it is a fact that the number of injuries and deaths of passengers is small compared to the number of passengers carried. This is said guardedly since there is still fresh in the memory of almost everyone the terrible disasters which have occurred on one of the eastern roads this last year.

The employees of a railroad can be divided into three classes: First, those who work in the shops and roundhouses; second, those who work in connection with the operation of trains, such as yard and switchmen; third, those who operate the trains, which include the engineer, conductor, fireman and brakeman. The men in the first class are like those in any industrial factory and can be protected somewhat by means of safety devices and can be helped by working in well lighted, well ventilated buildings, which are not overcrowded so that the aisles and passage-ways can be kept clear. There are not many known safeguards which can be used for the second and third classes of employees. These men must run no risks, be quick of action, have a clear vision and brain, and be sure that they are safe before doing anything. In 1910 there was started a "safety-first" movement among the railroads. At the end of this year there will be sixty-seven railroads having a total mileage of over 183,596, which have organized this movement among their employees. Not a week passes but other railroads are taking up this movement, until within a few years, all the railroads will have joined it. This is nothing more than a practical movement to interest and co-operate with the railroad employees so that they will always think and act "safety first." This is accomplished by various means, among which are workmen's safety committees, talks by railroad officials, illustrated lectures on safety and other methods. The men have appreciated what the companies are doing for them, and they are trying to live up to what is required of them, thereby "boosting safety." The railroads which are active in this movement have been able to show a surprisingly large reduction in the number of accidents. Some of these roads have fitted up cars with traveling exhibits of safeguards. They also carry lantern slides of safety devices and methods of protection. Each car is in charge of one of the road's safety engineers, who goes with the car to the different shops, roundhouses and yard terminals of the road, where he lectures to the men and shows them models of the different safety devices which the company uses.

The statistics given in the foregoing only refer to railroads doing interstate business. The street and interurban railroads, besides the intrastate steam railroads, come under the jurisdiction of the State public

* Reproduced from *Machinery*.

service or railroad commission, if such has been created by the legislature of the State. The greatest number of accidents which occur on the street railroads are in the getting on and off of moving cars. The prevention of this class of accidents is in the education of the passengers not to be in a hurry, but to wait till the car stops before proceeding to get on or off. The running or stepping in front of moving cars is always a source of great danger. A large number of these latter accidents happen to thoughtless school children. It might be mentioned that the accidents which have happened since the advent of the motor vehicle and motor truck have been increasing instead of decreasing. State and local ordinances have attempted to decrease speeding and reckless driving by chauffeurs. While these are not industrial accidents, everyone is vitally interested in preventing them as far as possible.

Ever since the "Titanic" disaster of April 15th, 1912, when 1,517 persons were lost at sea, the United States Government and the ship-owners have been trying to prevent a repetition of this calamity. As a result, ships which ply on the navigable rivers and lakes and those leaving ports of this country for foreign destinations, which carry more than 50 persons (crew and passengers), must be equipped with a wireless system having a day or night radius of 100 miles at least. This equipment must be so arranged that it can be independent of the engine room supply of electricity. They are also required to have at least two operators so that one will be on duty all the time. The ships must have enough lifeboats and rafts to accommodate all the passengers and crew. The lifeboats, rafts and life preservers are regularly inspected to see that they are in sea-worthy condition. Lifeboat and fire-drills by the crew are supposed to take place at regular intervals. Traveling by water to-day is far safer than it was four or five years ago. While it is a fact that some of the worst marine disasters have happened by collisions or by having the vessel tossed against a shore and knocked to pieces by the wind and waves, yet it is also true that the burnings of ships at sea, or in port, have been more numerous. The burning of the S.S. "Volturno" in the summer of 1913 is only one instance in a long line of such disasters. Even with all the latest apparatus for detecting and extinguishing fires, it sometimes happens that the fire gets beyond control. One of the greatest safeguards of the age, as regards protection at sea, has been the use of wireless telegraph in calling for help from other vessels. In December, 1913, there was held in London, England, an "International Conference on Safety at Sea," having representatives from twelve different nations. This conference will make a report as regards its findings.

In 1911 the fire in the Triangle Shirt Waist Company's loft occurred in New York, and another disastrous fire in Newark, N. J. The next year there was another large fire in a loft building at Binghamton, N. Y. In each of these fires there was a terrible loss of life among the young women workers in the shops. As the result of investigations conducted after these fires, several of the States have changed existing laws and have enacted others to protect the workers in factories and lofts from such disastrous fires. It would take too long to tell what has been done in the line of fire prevention, but mention will be made of the increased number of, and larger fire escapes built of firmer materials, of fire drills conducted in different shops, of more adequate fire fighting apparatus to extinguish a blaze in its incipiency, of buildings constructed of fire-resisting materials and of other methods by which the fire insurance companies and the owners of factories are improving conditions.

All the work of the Government commissions, bureaus, State boards, employers and other officials in accident prevention, hygiene and sanitation, would count for very little if it did not have the active co-operation of the workers themselves. There are several reasons why the safety movement has taken such big steps within the last year or two. One of these has been the awakening of the employers to the fact that they are their "brothers' keepers," and therefore it is their moral and rightful duty to take every means in their power to keep their workers in health and as free as possible from accident. Second, the employee realizes now that it is his duty to become a partner with his employer in carrying out any safety suggestions that will be helpful to both of them. Again, both the employer and his workmen know that they owe it to society at large to decrease the number of accidents and cases of sickness.

Among the agencies which are helping the progress of the safety movement are the museums of safety, one of which is now located in New York at 29 West 39th Street. Another will be started with the beginning of this year in San Francisco, Cal., and still a third will be located in Chicago, Ill., in the near future. Other museums are being considered by several of the State boards and by the National Government. These museums are stationary and can be seen only by those who are within a traveling distance of these cities or who may be sojourning in them. The lecture work which members of these museums can give need not be confined to these cities. In fact, during the last three years illustrated lectures have been delivered by officials of the American Museum of Safety before audiences of superintendents, foremen and workers of several large industrial plants and railroads. They have also given the same lectures before meetings of chambers of commerce, factory inspectors, organizations of employers, and others of a similar nature. This last year, safety talks have been given by the New York museum to 449,120 children of the schools of Greater New York.

Some of the railroads and large industrial concerns have printed safety talks which they have sent to the school authorities in the cities in which they are located, for distribution among the school children. Lecture work has been given by officials of the National Association of Manufacturers at the different industrial centers during the last few years. This association is proposing to widen its scope of lectures this coming year by fitting up a train which will carry the lecture officials One car of this train will be arranged so that it can become a moving picture theater, and another car will carry models and samples of various safety devices. One of the railroads already has a train of this nature for its own use and others are considering doing the same thing. Several of the State boards are doing lecture work among the manufacturers of their States. This educational lecture work has been a great help, to all concerned, and one of the leading factors that has brought the safety movement to its present state of development.

Another agency which is helping the movement is the co-operation of the technical journals in the publishing of editorials and articles by leaders of the movement, on questions relating to safety, sanitation and hygiene. The *Railroad Record* publishes once a month an issue devoted wholly to safety and safety engineering, and has each month a section given over to questions regarding safety. Several of the insurance companies which carry liability insurance have been actively promoting the safety movement among their insured. It is not unnatural that new organizations whose members consist of those whose interest centers about this movement, should come into existence as the work progresses. Among such organizations might be mentioned the American Mine Safety Association and the American Railway Safety Association. In Milwaukee, Wis., from September 30th to October 5th, 1913, there was held the "First Co-operative Safety Congres," under the auspices of the association of the Iron and Steel Electrical Engineers. At the end of this congress there was formed a National Council of Industrial Safety to serve as a committee for organizing future congresses. In New York there was held, from December 11th to 20th, 1913, the "First International Exhibition of Safety and Sanitation" under the auspices of the American Museum of Safety.

It has not been possible in as short an article as this, to give more than a general outline of the progress in the safety movement since its beginning. No mention has been made of other lines of progress in labor which have helped this movement nor has mention been made of what has been done by the legislatures and the employers in hygiene and sanitation. The safety movement has now become a permanent one in this country, and it will progress faster here than it did abroad, since America has their experience to draw from.

Sikorsky's Stupendous Biplane

SIKORSKY the Russian engineer has completed another machine nearly double the size of the previous one. The dimensions of this great biplane are stupendous. In span it measures 121 feet, the chord of the planes is 9 feet, the total lifting area no less than 1,950 square feet. From nose to tail the fuselage measures 65 feet. Driven by motors developing a total of 400 horse-power, the machine itself weighs about 7,500 pounds, or close upon 4 tons. On its first flight it carried ten passengers.

But the most remarkable feature of the "Ilia Muravetz," as the machine has been christened, is the accommodation for passengers, which is on a scale far more lavish than anything hitherto attempted. The great fuselage is entirely covered in; it measures 6 feet in height by 5¼ feet in width at the bow, and contains in the nose a small cabin for the pilots. Next comes the passengers' saloon—the word cabin is hardly adequate—with seats for fifteen passengers. Behind this is a small sleeping compartment, and still farther aft a tiny lavatory. The whole of these compartments are electrically lighted and heated by the exhaust from the engines. These consist of four 100 horse-power Argus motors placed two on either side of the fuselage, each driving a single propeller. These motors can be started singly or collectively from the pilot's cabin by means of a compressed air self-starting device, and each motor can be separately stopped and controlled by the pilot.

The tail consists of a fixed tail plane, a large elevator, and a triple rudder with an area of some 55 square feet. As the first trials were carried out when the ground was covered with snow, two skids were fitted in the first instance instead of wheels, but, on account of the excessive friction, a new chassis was designed, comprising four large disk wheels sprung on elastic shock-absorbers, and this proved eminently satisfactory.

SIZE AND STABILITY.

Sikorsky, therefore, seems to have succeeded in evolving what may justly be regarded as the forerunner of the great weight-carrying aeroplanes of the future, and this by simply utilizing the ordinary accepted principles of design. Save only in respect of a vast increase of dimensions, he has introduced not a single innovation. The wholly inclosed fuselage and the multiple-unit power plant have both been employed before. There is, in fact, no reason to prevent the construction at the present time of aeroplanes of similar or even larger dimensions; the one doubtful question is that of structural strength, owing to the magnitude of the stresses to be withstood. But here again Sikorsky appears to have proved that the existing methods of construction suffice to solve the problem, for the new machine is built of wood throughout, chiefly Russian pine and beech. Nor, in spite of the enormous total weight of the machine and the vast useful load lifted, is the net loading on the planes excessive, since it only amounts to just over 5 pounds per square foot of area, whereas in smaller machines the loading often attains 7 pounds or 8 pounds per square foot, and in the case of last year's Gordon Bennett racers it even worked out at 14 pounds per square foot.

Very evidently it is gradually becoming recognized that wind gusts are purely local in the great majority of cases, and of relatively small extent. Hence their effect on a small machine is much greater than on one of really large dimensions. The case may be justly compared to that of an Atlantic liner and a fishing boat; the former ploughs its way serenely through the largest waves, whereas the latter is tossed about in all directions; and a wind gust affecting perhaps one half of the area of a small monoplane would scarcely disturb the equilibrium of a machine measuring in span over 100 feet. Moreover, the larger aeroplane, possessing a much greater amount of inertia, will resist any upsetting influence to a far greater extent than a small machine.

REDUCTION IN WEIGHT.

But in another respect they certainly suffer from certain disadvantages. The large area of the controlling surfaces, such as the ailerons, for instance, requires a considerable exertion of muscular effort from the pilot to manipulate them in a gusty wind. Next there is the danger that a really severe gust may cause the ailerons to take charge and snatch the control from the pilot's hands. But here a solution of the problem should not be difficult to find, for the controls can be geared down.

The other objection is a more serious one. Large aeroplanes capable of lifting heavy loads are by their very nature slow, for good lifting qualities and speed are antagonistic, the more so since speed variation is incompatible with heavy loading. The big Grahame-White biplane never attained 60 miles an hour, nor did the first Sikorsky; nevertheless, even 60 miles an hour is insufficient, either for welfare or for employment for commercial purposes. Against a strong head wind such machines would barely make any progress. A war aeroplane and a commercial aeroplane alike should possess a top speed of not less than 70 miles an hour, which would render them serviceable in any wind short of a gale.

The most promising solution of this problem would appear to lie in the direction of a considerable reduction in the weight of aviation engines. Each of Sikorsky's Argus engines weighs, including the radiator, 480 pounds, which represents a total weight of nearly 2,000 pounds for the four engines, or almost 5 pounds per horse-power. To-day there are already available rotary motors weighing less than 2 pounds per horse-power, and stationary motors weighing a fraction over 3 pounds per horse-power. Even taking the latter figure, it is clear that no less than 800 pounds could be saved by Sikorsky, and this would give him an extra ten or twelve miles speed.

At the present moment, two questions relating to aeroplanes of more than ordinary size are of particular interest. First, because the examples given indicate definitely the inauguration of a new era, and secondly because of the several large machines now under construction in this country and abroad. The majority of these are seaplanes, such as the new Sopwith, which measures 80 feet in span and will be driven by two Austrian-Daimler engines, developing a total of 240 horse-power. For this type of craft, size and power are absolutely essential. Every consideration, in fact, points to the gradual increase in the size of seaplanes. What precise form they will eventually take is a question open to doubt.—*London Telegraph.*

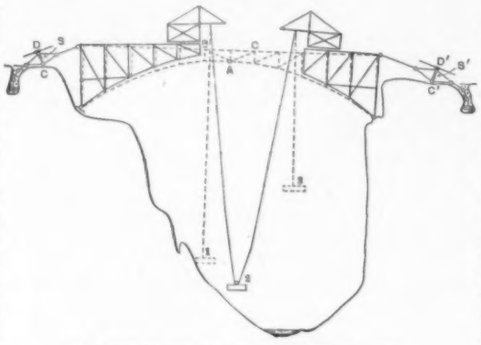
The Crooked River Arch

Engineering Skill Solves a Difficult Bridge Building Problem Despite the Use of Falsework

By C. E. Chase

A CANYON over 300 feet in depth, blocking the progress of the Hill system's Oregon Trunk Railway into central Oregon, was the problem that brought out in its solution one of the most interesting recent examples of the American bridge engineer's skill. The Crooked River arch is a notable structure because of certain novel features in its design, the spectacular and unusual method of its erection, the remarkable beauty of the completed structure in its rugged surroundings and its great height of 320 feet above water. Only one other bridge in the United States, the Pecos River viaduct, can surpass it in the last respect, and its lead is only a matter of inches.

The canyon that effectively put a stop to track-laying operations on the new line is a great gash cut through the basaltic rock of the plateau lying east of the Cascade Mountains, in the bottom of which meanders the insignificant little Crooked River. A crossing was laid out by the locating engineers at a point where the canyon walls are only about 350 feet apart and the south wall is vertical, even slightly overhanging, for its entire height. Work for the foundation of the structure was begun long before the track work was completed in the canyon of the Des Chutes, up which the Oregon Trunk climbs in penetrating to the center of the State. To get supplies to the isolated camp it was necessary to haul by team a distance of 65 miles from the nearest railroad point. Rock crusher, cableway, hoisting engine and concrete mixer were all freighted in, cement was worth $8 a barrel delivered at the bridge site. A cableway was put up across the canyon and pockets cut in the canyon walls to take the foundation of the arch, the rock from this excavation being crushed to make concrete for the pedestals on which the arch shoes were to rest.

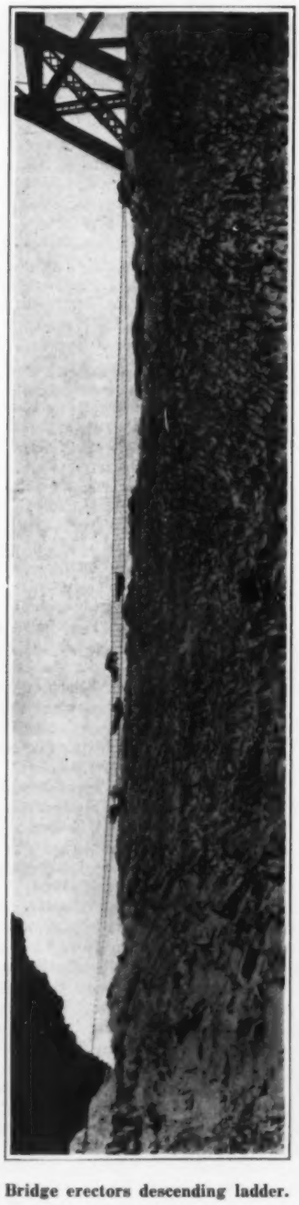


Method of erecting Crooked River arch.

Designs were prepared in the office of Mr. Ralph Modjeski, consulting engineer for the road, for a 340-foot spandrel braced arch of two hinges. The usual uncertainty that exists in arches of this type as to distribution of the load in the members at the center was avoided by placing a third hinge or pin at that point, to be used until the members of the arch trusses had taken their full dead load. Then, to get the stiffer action of a two-hinged arch under train loads, a top chord section was to be riveted into place (from the point marked *B* to *C* in the diagram) preventing any movement at the center hinge. A parabola was used as the curve of the bottom chord and the trusses battered or leaned inward at the top to give greater stability to resist wind pressures. The solid rock of the canyon walls provided ideal abutments to resist the immense thrust of the arch.

The great depth of the canyon made erection on falsework out of the question, so that the design was worked out to permit the two halves of the arch being cantilevered out from each side to meet at the center of the span. To hold the structure as it was built out the necessary 170 feet from each side, two 30-foot shafts were dug into the rock back from the edge of the hole on each side and in them were placed grillages of steel I-beams, from which a chain of I-bars ran to the ground surface. These holes were then filled with con-

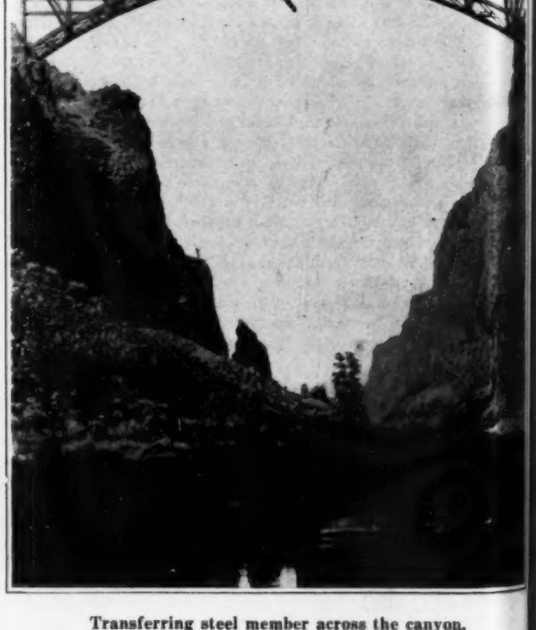
Erecting a diagonal member.



Bridge erectors descending ladder.

Completed arch viewed from abutment.

The north arch completed.



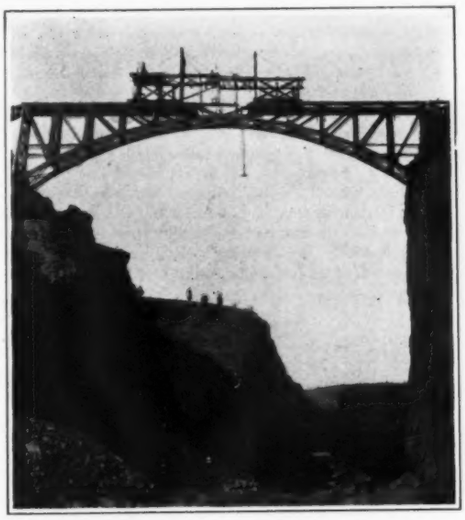
Transferring steel member across the canyon.

crete, and the I-bars were soon ready to take the load of 760,000 pounds that was to be put on them. As it was necessary to have some control over the two cantilever arms in making the connection at the center, they were built out in a slightly raised position, as shown in the diagram, and then lowered to place with the aid of a very large "toggle," placed in the chain of anchorage I-bars. In doing this, six or eight men turned, by means of a capstan, the big 7-inch screw *S* and thus brought the two points *D* and *C* closer together. Doing this increased the other diagonal of the parallelogram and allowed the arm to rotate about the pin at the foundation and come to bearing at the center.

In erecting, the bearing castings, or shoes, were first accurately set, so that the two arms would come together correctly in the center. A timber erection traveler with a 32-foot overhanging boom handled the steel as it was brought from the storage yard by a derrick car and built the structure out a panel at a time. As each panel was finished the traveler was pulled forward, the riveters started at work on the main tension connections, and erection continued in this way till the center of the span was reached. There, as steel could only be delivered to that side of the canyon, all the members for the other side were lowered from the end of the completed arm, transferred across the canyon and hoisted to place by a second erection traveler. The material for this traveler and the anchorage I-bars had earlier been taken across the hole on a light cableway. By this simple means 450 tons of steel was sent over for the south arm, the heaviest piece being one 72 feet long that weighed 14 tons. In crossing the canyon to work the men had to go either a half mile upstream where there was a trail down one wall and up the other, or scramble down the steep side under the bridge and then climb the rope ladder shown in the photograph, which hung from the vertical south wall for a distance of 250 feet. It was an occasion for rejoicing when the two halves neared each other so that the men were able to place a plank across from the outriggers of the travelers and come back to camp that way. The spectacular nature of the erection work brought the natives of the sparsely inhabited region in from distances of miles around. They sat all day on the edge of the canyon and watched with amazement the work of the bridgemen, who naturally always added a few flourishes when they had an audience. Despite the evident danger of the work, no lives were lost, nor were any of the men seriously injured.

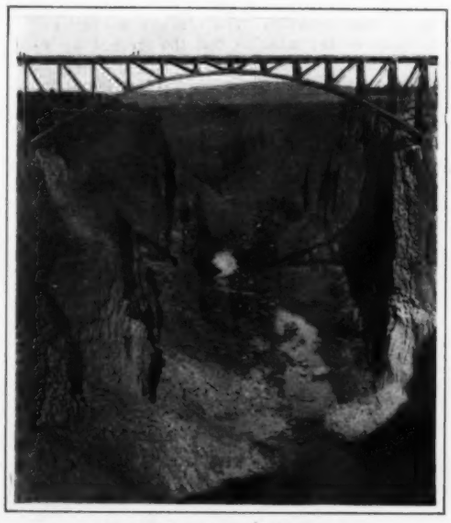
As soon as the two halves were joined the construction department of the road began to figure on getting across to finish the track laying to Bend, 27 miles away. As this was very important and the complete riveting would take some time, the holes in the important connections were filled with temporary bolts and drift pins and the 180-ton engine and track-laying machine allowed to pass over when only 50 per cent of the 40,000 rivets had been driven.

The finished arch is a beautiful structure, a simple and unornamented framework joining in a graceful curve the two rugged canyon walls, behind for a background the snow peaks of the Cascades.



Setting the last top chord member.

Lowering the semi-spans to bearing on center pin.



Completed arch from the west.

Deteriorating Marksmanship in the German Army

By Dr. Oskar Kallos, German Army

THE German technical press deplores the fact that good markmanship among soldiers is declining year by year. This decline is due to the fact that recruits, especially men from the city, are less efficient than formerly, owing to the prevalence of neurasthenia and various other debilities. General rules for instruction in shooting cannot be laid down, for each man's peculiarities must be taken separately into consideration.

Wherein does the operation of aiming consist? Evidently in correctly adjusting in the line of aim the object fixed, while holding the hand steady even at the moment of pressing the trigger. In other words, there must be a proper balance of the various nerves which enter into operation in the process. The left eye is closed in the act of aiming, so that the case is one of monocular vision in which the muscular tone and the equilibrium of the eye muscles play an important rôle. It is well known that if in normal vision an object is fixed with both eyes, and one eye is thereupon covered up with a screen, it still remains adjusted for vision of that particular object: the innervation of both eyes is closely connected, and this involuntary adjustment of the eye takes place also when one eye is closed. By nature we are built for stereoscopic vision and ordinarily we exercise this mode of vision. The sighting of one object with two eyes stereoscopically gives us the means of judging depth or distance.

It follows that the gaging of the distance of an object in one-eyed vision must be effected by some other process than stereoscopic vision, and therefore the proper location of objects seen with one eye is a process which must be *learned*. In aiming with one eye closed the muscular efforts of the left eyelid tends to exert a distracting influence. Under these conditions, even very slight disturbing factors, such as irritation by sound or adventitious light reflections, etc., are apt to disturb the equilibrium and to cause the right eye to blink.

An important point to bear in mind in the discussion of the influence of one eye upon the other are the peculiarities of the course of the optic nerves. Our readers may remember that the fibers of the optic nerve cross at a certain point known as the optic chiasma, forming an X, and that at this chiasma a portion of the nerve fibers pass across from the left hemisphere of the brain to the right eye and *vice versa*. As the result of that, images appearing on the left part of the eye are seen through the right branch of the optic nerve trunk and images appearing on the right half of the eye, are seen by the left hemisphere of the brain. Thus, in spite of the fact that the left eye is closed, the right half of the field of vision is seen through the left nerve trunk, while the point fixed in aiming and the lefthand side of the field is seen through the right half of the nerve trunk.

A normal individual learns to overcome the disturbing influence which this condition causes in monocular vision, but persons who are not very robust or in perfect health, such as those afflicted with neurasthenia, are apt to suffer from a fatigue of the nerve centers relating to special sense perception. In such cases I have often observed a slight tremor of the eye. The most common trait, however, seen in poor marksmen is the closing of the right eyelid either on pressing the trigger or just before doing so. How difficult it is to form a proper idea with single-eyed vision of the distance of an object in space, anyone can readily see for himself, by trying the following experiment: Fix an object first with both eyes, then suddenly close the left eye, and the object is seen to apparently move towards the left. This usually is observed even in the case of perfectly normal persons.

Another important disturbing agency is constituted by sound impressions. The effect of these is observed particularly in sharpshooting and may continue for some time by the retention in the memory of the effect of the effect of the sound. If these effects are not suppressed, they are apt to produce a certain nervous irritability (in neurasthenic subjects) causing tremors or blinking of the eyelids. My observations have shown me that these effects are much magnified when the left eye is closed and that better results are obtained if the left eye is merely covered but kept open.

I have also observed that intense fixing an object tends to increase the irritability of the auditory nerves. Neurasthenic subjects usually complain of singing of the left ear after target practice, and of other sensations which may continue for several hours. The remedy for these troubles must be found in removing, or at least reducing the factors which cause the disturbances mentioned. These disturbing influences are felt even by good marksmen at first, only in their case practice enables them to overcome these difficulties.

I have found that in the case of poor marksmen the same good results may be obtained by covering the left eye instead of allowing it to be closed. However, this should not be done by putting a flannel bandage over the eye, as has been the practice hitherto with persons who for one reason or another could not close the eyelid, but by means of a concave opaque shield for the left eye. In this way the left eye is allowed to move freely and there is an illusion of stereoscopic vision.

In my experiments I have used eye-covers made from flattened sheet zinc after the pattern of automobile spectacles. The cover was attached to the head by means of a rubber band. The results were that keeping both eyes open, the majority of poor marksmen were able to make a quiet, steady aim, without tremors of the hand or of the eyelids. They were able, without pressing the trigger, to keep the guns sighted for a considerable time, and men who previously after a lapse of two or three seconds, complained that objects swam before their eyes or that they felt a dizziness, were now able to point at the aim for twenty to thirty seconds without trouble. In the case of neurasthenic subjects and persons not accustomed to occupation of this kind, the reflex closing of the eyelid was not longer observable.

After these men had practiced for some time with the aid of the protecting cover, they were enabled to learn to shoot without this protection as well as other men.

An interesting exception are persons with imperfect eyesight who require spectacles for shooting. Experienced shots who have become short or far sighted in later years and who were good marksmen before this change occurred, overcome the spherical aberration of the correcting lenses by keeping their lids half-closed so that they form a diaphragm for the pupil. In unpracticed shots the voluntary muscles of the eyelids are incapable of doing the requisite work. In their case I recommend a pair of spectacles for both eyes, the coverplate of the right eye being provided with an oval opening, behind which the requisite correcting lens is placed. It is just as well to determine by the use of an optician's set of lenses, what particular lens is best adapted for the individual in shooting, and the shooting lessons are then given using this particular lens.

The disturbing sound effects are less important, and may be to some extent avoided by the well-known expedient of keeping the mouth open in shooting so as to permit the pressure on both sides of the ear drums to become equalized through the eustachian tube.

The Nineteenth International Congress of Americanists will hold sessions in both North and South America in 1914; viz., at Washington, and at La Paz, Bolivia. The Washington session will be held October 5th to 10th.

Applications of Electromagnetic Tripping Devices*

Mechanisms Which Prevent the Damaging of Machines or the Production of Defective Work

By George M. Meyncke

In designing automatic machinery or automatic feeds for standard machines, the designer often faces the problem of providing a suitable device that will make his machine absolutely fool-proof and reliable. This is particularly true in the case of automatic machines where one operator looks after several units. While it is not claimed that purely mechanical means cannot accomplish the same results which are secured through the use of electromagnetic tripping devices, the mechanisms would necessarily be so complicated, as compared with the electrical devices described in this article, that they would be a source of endless trouble, if not impractical. Another advantage of the electrical devices lies in the fact that they may be used as a check on the accuracy of preceding operations and thus avoid finishing pieces of work that are defective. The application of electricity to automatic machines may be regarded as a complication in itself, but this is far from being the case if these tripping devices are properly applied.

The following examples are typical applications of electromagnetic tripping devices to automatic machines,

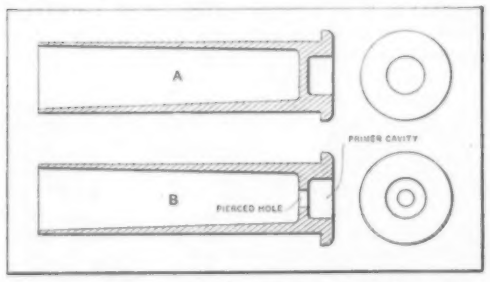


Fig. 1.—Cross-sectional views of shell before and after piercing primer hole.

and by studying these designs the reader will readily appreciate how similar tripping mechanisms could be applied to other classes of machinery; he will also appreciate how these devices put a check on the operation of the machines to which they are applied. In most of these examples, the tripping devices constitute part of attachments for standard machines that were converted into "automatics," thus dispensing with the necessity of an operator for each machine. Electricity performs the vital part of the work; it takes the place of the eyes of the operator and is far more satisfactory than eyes because electricity is more nearly infallible.

Fig. 1 shows a metallic cartridge shell *A* as it is received by the machine which pierces the primer hole, and a shell is illustrated at *B* on which the piercing operation has been performed. After the hole has been pierced, the primer is inserted in the primer cavity by the machine. These operations are performed on a standard Waterbury-Farrel cartridge primer. The shells were formerly placed on dial pins by hand and indexed under the crosshead for piercing and inserting the primer; they were then removed from the dial pins automatically. An improvement was made in the method of operation by applying an automatic feed mechanism to place the shells on the dial pins, but this did not dispense with the necessity of an operator for each machine, as there are three possible conditions that may result in the production of imperfect work: First, the feed mechanism might fail to deliver the shell to the dial pin, or the supply of shells might become exhausted, while primers would continue to feed and thus be wasted. Second, the piercing punch might break and the machine would then continue to place primers in the cavities of shells which had not been pierced, and such shells would obviously be useless.

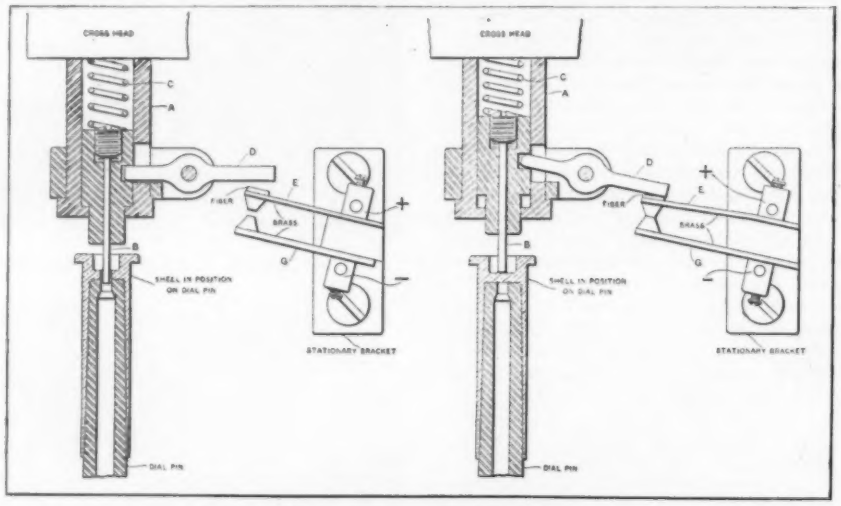


Fig. 2.—Tripping device which acts in case of failure of punch to pierce the shell, as shown in right-hand illustration.

Third, the primer feed might fail to work properly, or the supply of primers might become exhausted.

The application of a suitable electromagnetic tripping mechanism to this machine now takes care of all of these contingencies. First, we will consider the possibility of the feed mechanism failing to deliver a shell to the dial pin. Referring to Fig. 3, it will be seen that the shells are carried on index points of the dial which carry them under the punch *A*. If a shell is in its place on the dial pin it contracts the spring *B* when the ram descends, but should the mechanism fail to deliver a shell to the pin, the sleeve *G* passes down over the dial pin and pushes the upper contact *D* of the tripping mechanism down upon the lower contact *E*. This closes the electrical circuit and stops the crosshead on the up-stroke. The contacts are fastened to the frame of the machine and the method by which the tripping mechanism operates will be described in detail later. The way in which the piercing operation is safeguarded by the electromagnetic tripping mechanism is illustrated in Fig. 2. The punch holder *A* is located at the index point immediately after the completion of the piercing operation. If a shell is pierced, the pin *B* descends through the hole in the shell, as shown at the left-hand side of the illustration; but if the piercing operation does not take place, the punch is held in the position indicated in the right-hand illustration, thus contracting the light spring *C* and throwing the lever *D* against the contact *E*. This closes the electrical circuit and causes the machine to be stopped so that shells cannot have primers inserted in them when the primer hole has not been properly pierced. The failure of the machine feed to a primer into the primer cavity of the shell is guarded against by the mechanism illustrated in Fig. 4. The design of this tripping mechanism is practically the same as that used to control the piercing operation and will be readily understood without further description.

Fig. 5 illustrates a press which is used for assembling the brass cups *A* and *B*, the cup *A* being inserted in the cup *B*. These cups are held in hoppers on each side of the machine from which they are taken by notched dials. The cups *A* are dropped into holes in the machine dial which passes over the dial carrying the cups *B*. We will not go into the method by which the machine operates here, it being sufficient merely to state that a plunger descends in such a manner that the cup *A* is forced into place in cup *B*. It will be readily seen that several conditions may occur that will result in loss or damage, i. e., the feed mechanism could fail to deliver either one or both cups to their respective dials, or it could deliver them to the dials in an inverted position. Fig. 5 illustrates how either the absence or inversion of either or both cups is detected by an electromagnetic tripping device which automatically stops the machine until the error has been corrected. The punch *C* is located at an index point preceding the assembling punch and is carried by a bracket which is fastened to the crosshead. In the case of an inverted cup, the punch *C* is held on the bottom of the cup and

* Reproduced from *Machinery*.

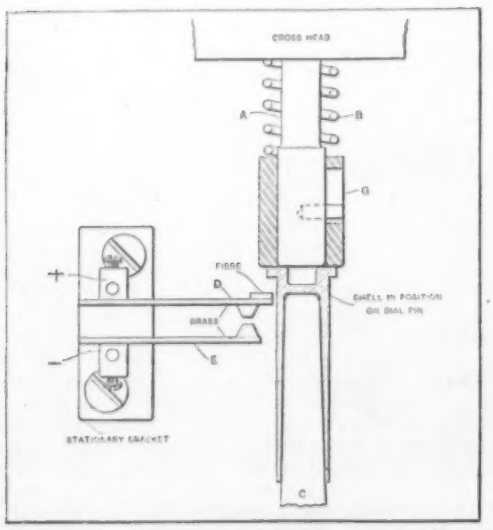


Fig. 3.—Tripping device which acts when a shell has not been placed on dial pin.

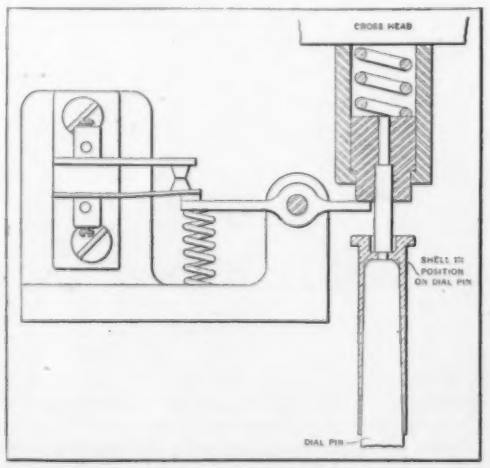


Fig. 4.—Trip which prevents passing on a shell without a primer.

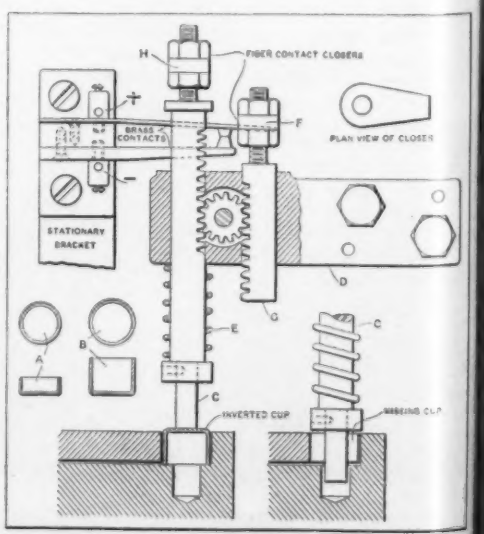


Fig. 5.—Trip used on machine for assembling cups A and B.

pulls the rod *G* down through the action of the pinion, which engages with rack teeth cut in the rods *C* and *G*. The descent of the rod *G* causes the contact closer *F* to pull down the upper electrical contact until it closes the circuit and causes the machine to be stopped. The right-hand illustration shows a detail of the punch and die when the feed mechanism has failed to deliver a cup to the dial plate. In this case, the upper electrical contact is pulled down by the contact closer *H* and causes the machine to be stopped as previously described.

Fig. 6 shows the electromagnetic tripping device used on the machines referred to in the preceding paragraphs. In this illustration, the tripping device is shown in place on a power press equipped with a Horton clutch. The design and contraction of the tripping mechanism will be more readily understood by referring to Fig. 7, which shows an end and cross-sectional view. This tripping mechanism is self-contained and can be applied to any style of press or type of machine. It will be seen that the bracket *A* carries the magnet *B*, pole-piece *C*, and levers *D* and *E*. The brass pole *G* is wound with No. 14 double-covered wire and the lead wires are carried off through the back of the spool. The brass pins *H* help to support the pole-piece *C* and provide adjustment for different widths of air gap which should be as small as possible. In order to start the press, the lever *E* is pulled down. This pulls out the flywheel clutch (see Fig. 6) and allows the spring *J* to pull the lever *D* over the hardened knife-edge, thus setting the pole-piece *C* at the proper working distance from the magnet. The inside dimensions of the device are given in Fig. 7, and when the magnet is energized by two dry cells, it gives an initial pull or jerk of from twelve to fifteen pounds. As the dry cells are used on open-circuit, except for the fractional part of a second during which the contacts meet, they have a long life.

The initial pull provided by an electromagnet of this kind varies with the material used for the magnet and pole-piece. Where cast iron is used, the pull of the magnet can be calculated by the following formula:

$$NI = 3{,}000\ Z \sqrt{P + D}$$

in which N = number of coils of wire on spool (ampere-turns);
I = current in amperes;
P = pull in pounds;
Z = air gap in inches;
D = diameter of plunger in inches.

The electromagnet shown in Fig. 7 was designed to give a pull of fifteen pounds, and it will be seen that $Z = 5/16$ inch and $D = 1.125$ inch.

Then $NI = 3{,}000 \times 5/16 \sqrt{15 + 1.125} = 3{,}423.19$ ampere-turns.

Assuming that there are 375 turns of wire on a spool, the amount of current required will be found to be $\frac{3{,}423.19}{375} = 9.14$ or, say, ten amperes. Two good dry cells connected in series will average fifteen amperes during their useful life and give a considerably higher current when new. As ten amperes is sufficient to enable the electromagnet to do the work required of it, it will be seen that an ample factor of safety is provided. When designing devices of this kind, moving wires and moving contacts should be avoided and the mechanism should be made as simple as possible. The dry cells should be used on open circuit, the contacts carefully insulated from the machine and covers provided for contacts and terminals.

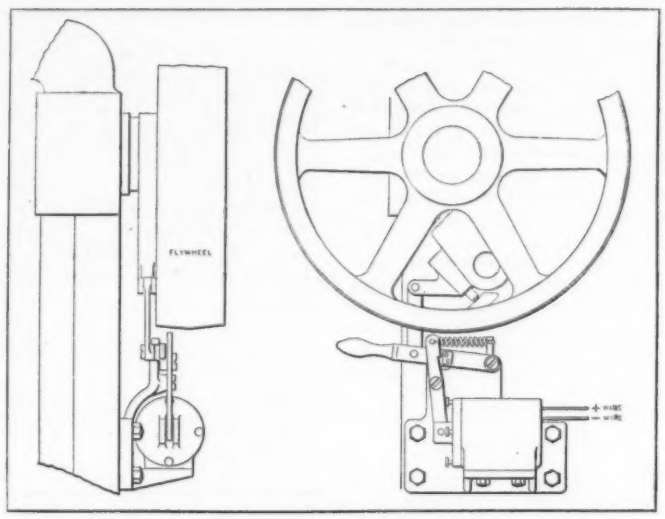


Fig. 6.—Electromagnetic tripping device applied to power press equipped with a Horton clutch.

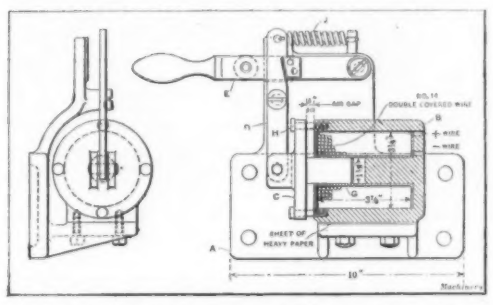


Fig. 7.—End and cross-sectional views of electromagnetic controller.

The Measurement of Vessels for the Panama Canal

Dr. Woodrow Wilson, President of the United States of America, has recently proclaimed the Rules for the "Measurement of Vessels for the Panama Canal." We must confess to some disappointment on finding that the Suez Canal Rules have been made the main basis for the Panama Canal Rules. We had hoped that the American Government would have viewed the Panama Canal more as an investment for strategical and naval purposes than as a commercial venture requiring the earning of interest on the immense capital which has been sunk in the undertaking. As it is, the general effect of the Panama Canal Rules appears to be that the gross tonnage as measured by these Rules will be slightly greater than the Suez Canal gross tonnage, but, with the more liberal allowances permitted by the Panama Rules, the net tonnage (upon which dues are charged) will be somewhat less.

By the Panama Rules, all vessels, American and foreign, except warships, applying for passage through the Panama Canal will be required to present a duly authenticated certificate stating the vessel's gross and net tonnages as determined by these Rules. Should such certificate not be forthcoming, then the vessel will be measured and her tonnage determined in accordance with these Rules before she passes through the canal or is allowed to clear therefrom. The officials who may measure vessels and issue certificates are those who are authorized in the several foreign countries and in the United States to do so for purposes of national registry, and such other officials who may be authorized by the President of the United States to measure vessels and to issue Panama Canal tonnage certificates. Warships, American and foreign, will be required to present duly authorized displacement scales and curves stating accurately the displacement tonnage at each possible mean draught.

The measurement of the under-deck tonnage is the same according to the Panama Rules as for the British and Suez Canal Rules for vessels constructed with double bottoms, having the inner bottom horizontal; but by the American Rules the tonnage of double-bottom spaces intended for oil fuel and feed water is added. The space for feed water is, however, deducted from the gross tonnage independently of the allowance for propelling power. In the cases of vessels constructed with double bottoms, in which the inner bottom is higher at the margin than at the middle line, the Panama measurement will be the same as the British under-deck tonnage, which is about 3 to 4 per cent greater than the Suez Canal tonnage. American vessels having double bottoms of the form described are measured for their national registry under the Suez Canal Rules, and for the Panama Canal certificate the under-deck tonnage will be increased accordingly, and be in agreement with the British Rule.

By the provisions of the Board of Trade, large exemptions are allowed, under certain conditions, as regards the measurement of deck erections, such as poop, bridge-house, and forecastle. Under the Suez Canal Rules, such spaces are comprised in the gross measurement, with only very limited deductions; while under the Panama Rules the measurement of these spaces will be somewhat more stringent than under the Suez Canal Regulations. In shelter-deck steamers of the usual type, having one or more tonnage openings in the deck, the shelter-deck space is exempted from measurement under the Board of Trade Regulations; but under both the Suez and Panama Rules such space is required to be completely measured, unless there are openings in the side plating without means of closing the same, in which case the space only in way of such openings is exempt from measurement. As is well known, shelter-deck steamers and vessels with open poops and bridges occasionally load light cargo on the shelter-deck and on the poop and bridge respectively; and according to the practice of the Suez Canal Company, when once a vessel passes through that Canal with cargo in these spaces, she is ever after charged dues on the spaces whether there is cargo in them or not. This regulation, which is obviously unjust, is a constant source of irritation, and we are surprised to observe that a similar regulation has been adopted by the United States Government. In the Board of Trade Regulations, provision is made whereby vessels engaged in the over-sea trade when carrying cargo in the exempted spaces shall have the tonnage of the space occupied added to the taxable tonnage only for the voyage during which such cargo is carried. This is a reasonable regulation and commends itself to us as justifiable and common-sense. On the whole, it would appear, as we have said, that the gross tonnage of a vessel measured by the Panama Canal Regulations will slightly exceed that obtained by the Suez Canal Regulations, and both these are much greater than the gross tonnage according to the Board of Trade.

Under all three Rules, to obtain the net tonnage upon which dues are payable, certain deductions are allowed from the gross tonnage. The allowances for propelling power are the same under the Panama and Suez Rules. The British allowance is, in the great majority of vessels, a percentage of the gross tonnage, but the Panama and Suez allowance is either 1¾ times the space of the engine-room, or, if the vessel has fixed bunkers, the actual measured tonnage of engine and boiler space plus the fixed bunkers; but this allowance must not exceed 50 per cent of the gross tonnage of the vessel, except in the case of tugs. In either case the allowance for propelling power is, as a rule, much less than that granted by the Board of Trade. As regards other deductions, we are glad to know that the Panama Rules for master's accommodation, crew, and navigation spaces, and peak water-ballast tanks, follow the lead of the Board of Trade, and not that of the Suez Canal, which makes no allowance whatever for the master's accommodation, and limits the allowance for crew and navigation spaces to 5 per cent of the vessel's gross tonnage. The Panama and Board of Trade Rules allow the space for the master's accommodation to be deducted, and do not limit the allowance for crew and navigation spaces to a percentage of the gross tonnage. Further, the Suez Canal Rules do not permit any deduction to be made on account of peak water-ballast tanks, whereas both the Panama Rules and the Board of Trade Rules do.

To illustrate the importance of these Rules to the shipping community, it is interesting to note that under the Board of Trade Rules a shelter-deck steamer 410 feet by 54 feet by 25 feet, having an exempted 'tween deck space, is computed to be of about 4,400 tons gross and 2,700 tons net, whereas the Suez Canal gross tonnage of the same vessel would be about 6,000 tons and net 4,500 tons. Again, to take the case of an ordinary cargo steamer 375 feet by 52 feet by 25.5 feet, with poop, bridge-house, and forecastle, the Board of Trade net tonnage works out at about 2,800 tons, against 3,500 tons by the Suez Canal Rules. The tonnage for fees by the Panama Canal Rules would be somewhat less than that by the Suez Canal Rules.

It will be seen that the United States Government have pretty closely followed the Suez Canal Rules. We think, however, that they would have been well advised for the success of the great waterway which their courage and enterprise have created in the face of enormous difficulties, if they had taken a broader view in drawing up their regulations. While there are several steamship routes where the advantages of using the Panama Canal are overwhelmingly great, there are others in which the advantages and disadvantages are much more evenly balanced. In the latter case, the question of cost will

play a very important part, and it is to be hoped that in drawing up the scale of fees which will be chargeable to shipowners using the canal, the United States Government will see the wisdom of adopting a moderate charge. —*Engineering.*

Stellar Photography for Amateurs*

By W. H. Steavenson, F.R.A.S.

CONSIDERING the large and important part now played in astronomy by the photographic plate, it is strange that comparatively few amateurs are actively interested in this branch of the science. No doubt most users of telescopes have tried their hand at photography at some time or another, but such attempts are too often limited to the taking of a few snapshots of the sun or moon in the principal focus of the instrument, which is then applied once more to some line of visual work with results that are generally of questionable value. Without wishing for one moment to discourage useful visual work, it is the aim of the writer to show the great possibilities of stellar photography from the point of view of the amateur and to suggest a few branches of astronomical work to which he may profitably apply it.

A few words on the subject of equipment may not be out of place. A common mistake on the part of beginners is to attempt work on too large a scale, using the biggest apertures and longest foci at their command. After what has been done by Roberts, Keeler and Ritchey, however, it is doubtful whether many amateurs could make any useful advance in the photography of individual clusters and nebulæ. It is in small-scale and wide-field work that the average amateur will find it most profitable to engage. The exact size and make of the lenses used must, of course, be largely a matter of individual choice; but whatever choice is made there are at least two qualities which a lens to be used for stellar work should possess, namely, great rapidity and great covering power. Slow lenses may, of course, be used, but the necessary exposures will be so long that it will be hardly worth while to use a lens whose aperture is less than *f*5 or *f*6. Unless expense is no object it is perhaps best not to try to combine extreme rapidity and good covering power in one and the same lens. It is much better, if possible, to have two lenses—a portrait lense for rapid work on small areas and an anastigmat for large fields. The portrait lens should have a working aperture of *f*3 or *f*4, and should be of at least twelve inches focus. Such lenses are often to be picked up quite cheaply in second-hand shops. Their covering power is rather poor, and if the focus is not above twelve inches or so there is no point in using anything larger than a quarter-plate with them. As a rule, their limit of fair definition does not extend beyond a circle eight or ten degrees in diameter. The anastigmat should be of about eight inches focus, should work at *f*4.5 or *f*4.8, and should cover a half-plate sharply at its full aperture. Under such conditions the lens will cover an area in the sky of thirty by forty degrees, or considerably more than four times the area enclosed by the four chief stars of Orion. The portrait-lens and the anastigmat may be used simultaneously, thus acting as mutual checks on each other's work. If they are used separately, the former will obviously be employed for detailed work on small areas, while the latter will be used when it is necessary for any purposes to cover a large region of the sky at once. Of course, for all photographic work necessitating long exposures an equatorial stand is absolutely essential; but it may be a very simple one, and need not even be provided with a clock. The latter adjunct is an obvious advantage as a saver of labor, but, given the requisite patience on the part of the operator, excellent results may easily be obtained with hand driving alone. Unless the telescope is a large one it is best to attach the cameras as counterpoises to the instrument, as this saves unnecessary weight, which is apt to militate against smooth and easy driving. For guiding, the out-of-focus image of a star, bisected by cross-wires in the eyepiece of the telescope, should be used. In order to correct for refraction, a slow motion in declination is essential. Care should be taken to follow accurately to within a few seconds of arc, as even small errors are much more noticeable on photographs than might be expected.

It now only remains to indicate in a general way some of the uses to which such lenses as those mentioned above may be put. First there is the search for variables and *novæ*. In this branch of work it is best not to try to cover too much ground at once, but to work systematically on one small region at a time, preferably with the portrait-lens. A small part of the sky, in or near the Milky Way, should be selected and photographed repeatedly with the same instrument at intervals of a few days, the plates being carefully compared by superposition or some other method. For the detection of short-period variables it is best to make several exposures of equal length and at equal intervals on the same night, moving the camera slightly for each exposure. The result will be a number of images of each star, which will be of equal intensity in every case, unless there is in the region a variable undergoing rapid change at the time, in which case it can at once be detected by the inequality of its various images. This method has been used with good results by Prof. E. C. Pickering at Harvard.

Another use for the photographic lens is in the search for comets. For this the anastigmat, on account of the large field it covers, is especially suitable. A region of the sky not too far from the sun should be chosen, and the photograph taken as near to the time of sunset or sunrise as the length of the twilight will permit. The writer would particularly recommend this branch of work to observers living in or near the tropics, where the twilight is of short duration. For the actual study of the changes in comets' tails the portrait-lens, on account of its rapidity, is more suitable than the anastigmat, though both may be used.

The visul study of the paths and radiants of meteors may very profitably be supplemented by work with the camera. Owing to the rapidity of their flight, only the brighter meteors will record themselves, but a few definite lines on a measurable plate will be of more value in determining the position of a radiant than any number of loose statements based merely on eye-estimations. Though not strictly speaking "stellar" in character, comets and meteors have been included in this article as being objects which are photographed under essentially the same conditions as the stars themselves.

There are many other ways in which photography can help the amateur astronomer. Its value as a means of map-making is considerable. It is often desirable, for the identification of faint satellites and for other purposes, to have an accurate map of some region which shall show all stars down to a fairly low magnitude. To those who cannot afford to buy the Franklin-Adams charts or the Astrographic Atlas, a home-made map, made in an hour or two with a portrait-lens, will often be very useful.—*Knowledge.*

Sunlight and Organic Synthesis

OUR English scientific colleagues, apparently mindful of the dictum that the goal of science is nothing short of the complete interpretation of the universe, have of late been busily and almost acrimoniously engaged in a discussion of the origin of life. Few of us who are absorbed in the busy occupations of an eminently practical profession stop to consider what must be, or have been "the first stage in the evolution of organic from inorganic matter at the dawning of life in a world hitherto devoid of anything organic."[1] When, however, the possibilities of this first primeval step are presented in terms of simple reactions which all of us can appreciate, the pleasure of speculation finds ready devotees in the members of the medical profession; for when one, like a physician, is dealing day after day with the behavior of protoplasm in both its normal and its pathologic manifestations, he is likely at some time in a moment of exalted inspiration to ask himself some of these fundamental questions as to its origin.

In the vegetable kingdom we already recognize in chlorophyl, the green coloring-matter of plants, a substance capable of acting as a transformer of light-energy whereby the synthesis of organic from inorganic matter takes place. The distinguished chemist Baeyer long ago suggested that the initial stage in the synthesis of organic from inorganic matter by the green plant consists in a reaction of such simple compounds as carbon dioxid and water to produce formaldehyde and oxygen:

$$CO_2 + H_2O \rightarrow H.CHO + O_2$$

The external energy which is necessary in any such transformation, because the reacting substances—carbon dioxid and water—are fully oxidized and must be reduced with evolution of oxygen and uptake of energy in what is termed an endothermic reaction, can be supplied from the energy of light vibrations. The formaldehyde is actually known to be thus formed; but in view of its toxicity it does not accumulate as such in the plant, being rapidly converted into more complex substances—possibly to carbohydrates.

Chlorophyl and its analogues are themselves highly complex organic substances and merely serve to push the inquiry a step backward. It has been necessary to search for processes in which the beginnings shall be confined solely to reactions in the inorganic world, under conditions which might exist in the new world we know. The first successful attempts have consisted in the production of organic substances by the action of light on purely inorganic substances.[2] Moore and Webster,[3] in London, have now succeeded in inducing such synthesis of organic matter (aldehyde) in the presence of inorganic colloidal uranic and ferric hydroxids in very dilute solutions, the latter acting as catalysts for light-energy just as does the chlorophyl of the green plant. These inorganic catalysts are not rare, and in the words of the English biochemists, "such a synthesis occurring in nature probably forms the first step in the origin of life."

The process of evolution of simple organic substances thus having been demonstrated in an environment of sunlight and simple inorganic compounds, we can more readily picture the subsequent steps in which derivatives of more complex organic nature would arise from these with additional uptake of energy; but at this point we fancy some one asking, How about the production of the living from the lifeless organic matter? To this we must answer that there is mystery enough in the domain of medicine without attempting for the moment to penetrate into such ultimate secrets.—*Journal of the American Medical Association.*

[1] Speculations in this field are presented in an entertaining way by Moore, B.: The Origin and Nature of Life, Williams and Norgate, London, 1912.

[2] Usher and Priestly: Proc. Roy. Soc. London, 1906, B. lxxvii, 369; lxxviii, 322.

[3] Moore, B., and Webster, T. A.: Synthesis by Sunlight in Relationship to the Origin of Life; Synthesis of Formeldehyde from Carbon Dioxid and Water by Inorganic Colloids Acting as Transformers of Light Energy, Proc. Roy. Soc. London, 1913, B. lxxxvii, 163.

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